

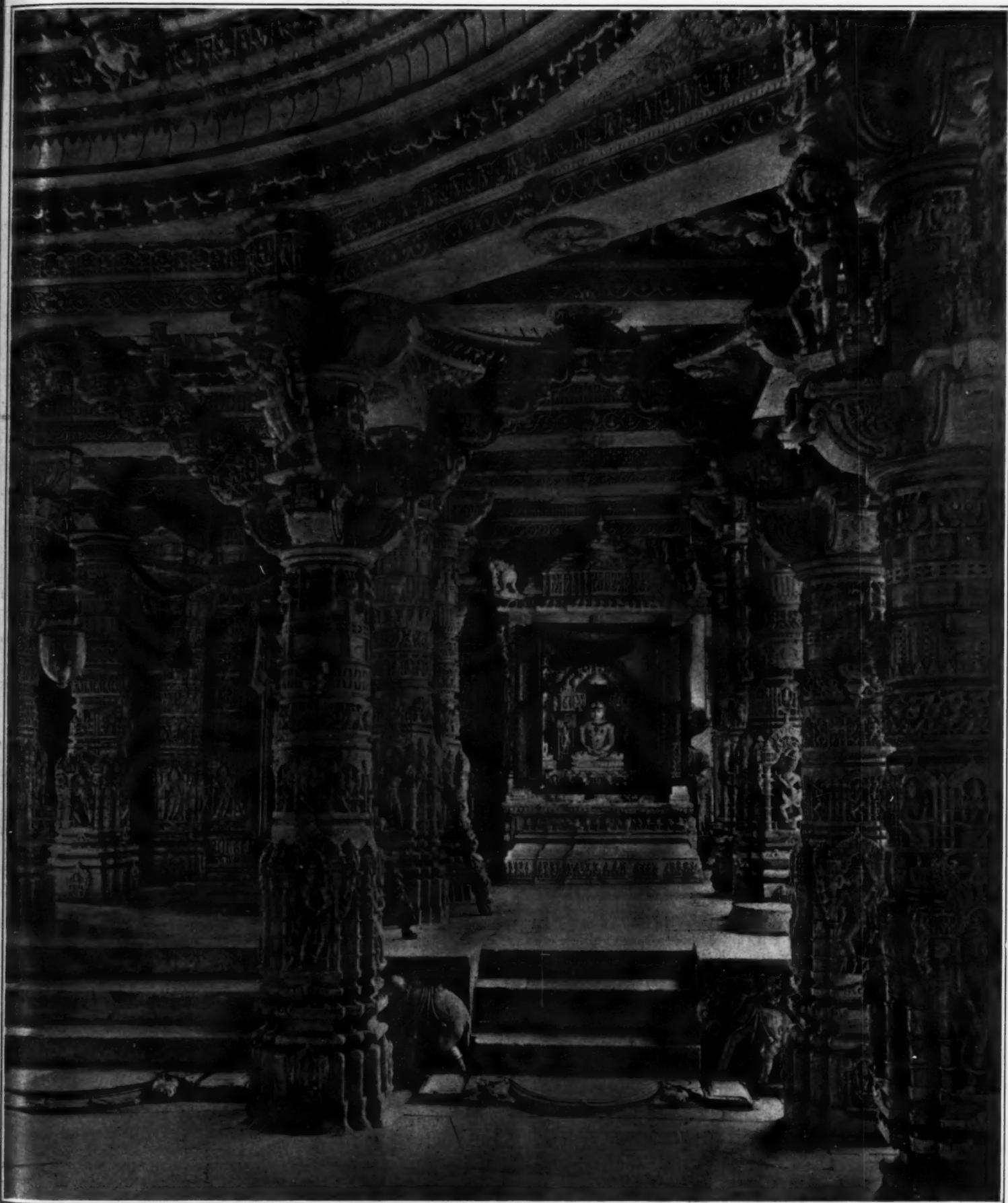
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A Jain Tirthanker (sage) and minutely carved portico, Dilwara white marble temples at Mount Abu (Rajputana, India).

THE TEMPLES OF DILWARA.—[See page 200.]

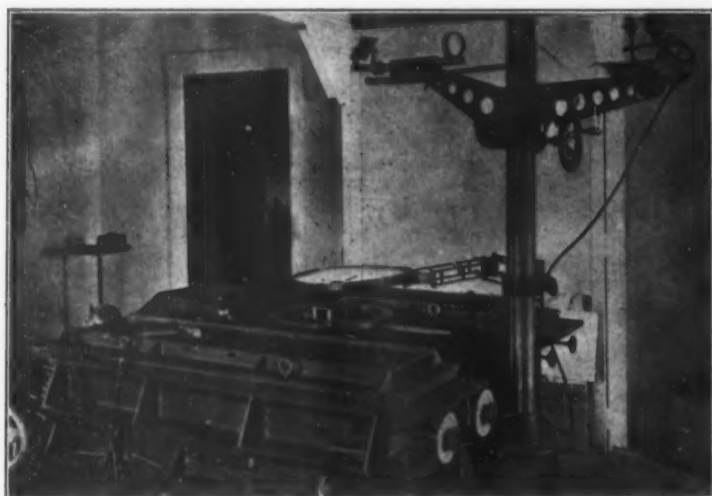


Fig. 1.—Head of 75-foot spectrograph showing plate holder, polarizing apparatus and parallel motion device used for centering solar image.

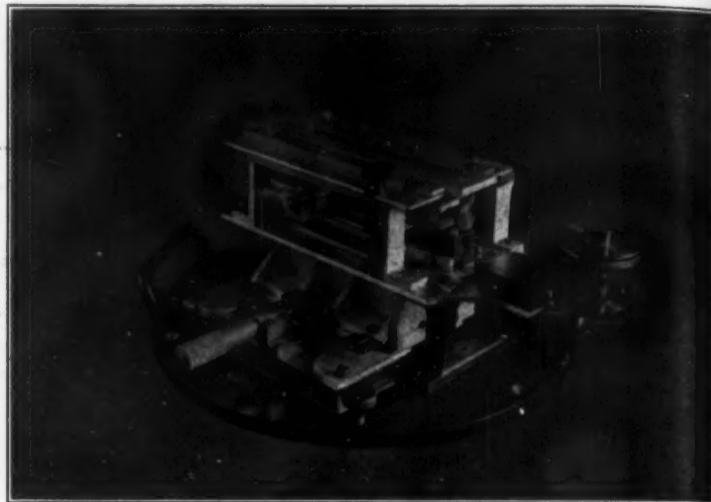


Fig. 2.—Slit and polarizing apparatus of 75-foot spectrograph with compound quarter-wave plate in position for observation.

Magnetism of Celestial Bodies*

An Investigation in Solar Physics Conducted by the Mount Wilson Observatory

By George E. Hale

THE cause of the earth's magnetic properties has long been a subject for scientific inquiry. The fact that the earth's magnetic poles are located in the neighborhood of the geographical poles suggests that there may be a connection between the earth's rotation and its magnetism. A number of theories of terrestrial magnetism have accordingly been developed from this standpoint. Most of these theories are at some point or other hard to reconcile with observed facts. Perhaps the most plausible theory is that brought forward by Prof. Schuster, who assumes that every molecule is a magnet. If this magnetism is accounted for as the effect of the rapid revolution of electrons within the molecule, a gyrostatic action may be anticipated. That is, each molecule would tend to set itself with its axis parallel to the axis of the earth, and the earth's magnetic field would result from the combined effect of all the molecules.

The chief advantage of this theory lies in the possibility that it may explain the secular variation of the earth's magnetism by a precessional motion of the magnetic molecules.

As a general problem of physics, the suggestion of Schuster that every rapidly rotating body may produce a magnetic field is of fundamental importance. Since it appears to be beyond the reach of experimental test, owing to the limitations of size and rotational velocity imposed by laboratory conditions, we may take advantage of astronomical phenomena, where these limitations no longer obtain. The existence of the earth's magnetism is favorable to the hypothesis, but it remains to be determined by the observation of other heavenly bodies whether such magnetic phenomena as they may exhibit are in harmony with its assumptions. The most promising opportunity is afforded by the sun, which meets many of the necessary conditions. Its great radius and angular velocity of rotation should give

rise to a field more than four hundred times as intense as that of the earth. Its atmosphere contains self-luminous vapors, giving line-spectra capable of revealing the magnetic field by the Zeeman effect. Its brightness is sufficient to permit the use of the very high dispersion required to detect a field so much weaker than



Fig. 3.—Region of λ 5930 photographed in the third order with the 75-foot spectrograph showing the division of the spectrum into 2-millimeter strips by the compound quarter-wave plate. The heavy horizontal line marks the junction of two sections of the Nicol. The fifth strip below is the "marked strip" used for reference purposes. Scale: 1 A = 4.90 millimeters.

the fields usually employed in laboratory studies of radiation. Finally, its axial rotation and large angular diameter facilitate observation at a great number of points on its surface, while the position of its axis, allowing line displacements to be measured near both poles, enables the observer to apply the most perfect test of the

Zeeman effect—the reversal of the sign of the displacement with the polarity. A very important limitation, however, must not be overlooked. We know that the sun contains free electrons, and that the positive and negative charges are definitely segregated in sun-spots and probably also in the chromosphere, where the more active negative electrons tend toward higher levels. Hence magnetic fields, local and general, may result from the motion of these charges. It is possible, nevertheless, to determine accurately the part played by free electrons in spots, and their effect on the general magnetic field may not be beyond the range of investigation.

From the standpoint of the physicist, therefore, the sun may prove of service by throwing some light on the hypothesis of the magnetism of rotating bodies. But the problem is of no less interest and importance from an astrophysical point of view. The discovery of powerful magnetic fields in sun-spots in a previous investigation indicated the possibility of a general observational attack on solar magnetic phenomena. The Zeeman effect was found to extend well beyond the limits of the penumbra of the sun-spots, and the configuration of the hydrogen flocculi suggested that with suitable polarizing apparatus local fields, sometimes of great extent, might be detected in regions far removed from visible spots. The next logical step was the exploration of the sun's general field as distinguished from local fields in the neighborhood of sunspots which are presumably due to electrons in motion in the vortex of the sun-spot.

So far as I am aware, the only direct method of detecting the magnetic field of the sun is by the observation of the Zeeman effect. An indirect method, first applied by Bigelow to the corona in 1889, led him to infer that the sun must be a magnet because the coronal streamers, especially near the poles, agree well in form with the lines of force of a magnetized sphere. Störmer has recently calculated the trajectories of electric cor-

* Condensed from Contribution No. 71 from the Mount Wilson Solar Observatory, published by the Carnegie Institution at Washington.

¹ Contributions from the Mount Wilson Solar Observatory, No. 30; *Astrophysical Journal*, 28, 315-343, 1908.

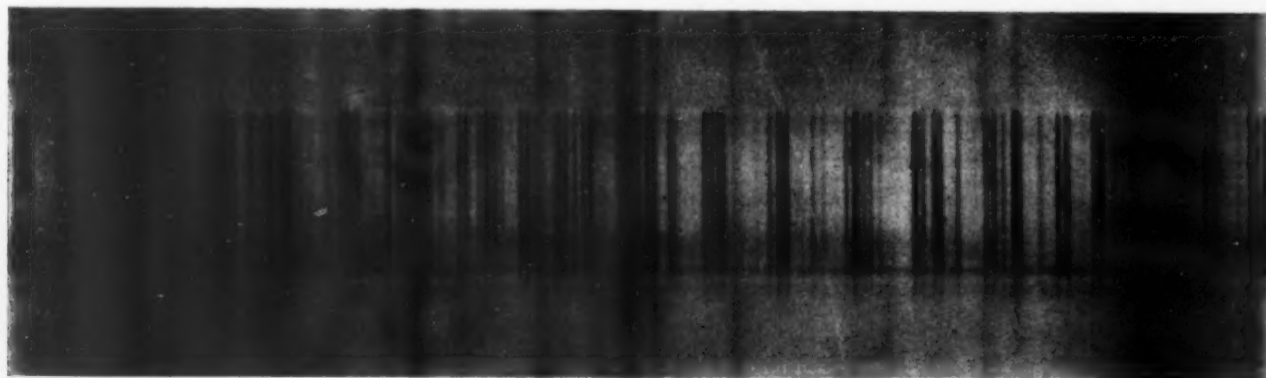


Fig. 4.—Solar spectrum and absorption spectrum of iodine vapor, region of the D lines of sodium, photographed in the third order with the 75-foot spectrograph. Slit-width, 0.127 millimeter. Central section, solar and iodine spectrum, exposure 35 minutes. Adjacent sections, solar spectrum, exposure 24 minutes. Scale: 1 A = 27.8 millimeters. Enlargement 5.7 times.

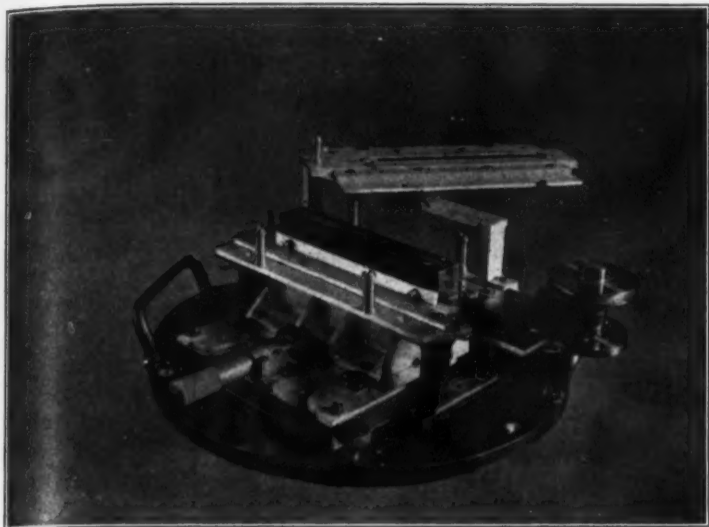


Fig. 5.—Showing the long Nicol prism mounted immediately above slit.

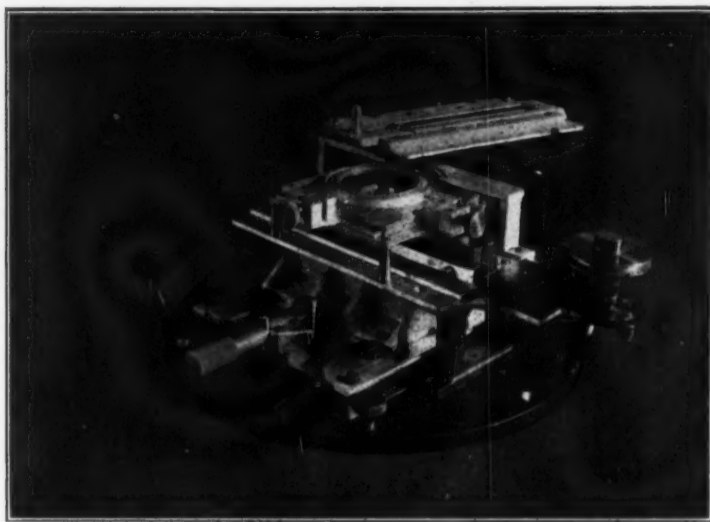


Fig. 6.—Showing the circular half-wave plate in position above the Nicol.

Slit and polarizing apparatus used with the 75-foot spectrograph, compound quarter-wave plate swung to one side.

pulses moving out from the sun under the influence of an assumed magnetic field, and the resulting curves closely resemble the structure of the corona. Finally, Deslandres has applied the same idea in the case of the prominences, and concludes from their forms and radial velocities that the ions which compose them are moving under the influence of the sun's field. The results already obtained by these methods are of extreme interest, and promise to be of even greater importance when fully developed in the future. It should be noted, however, that any conclusions thus reached as to the sun's general field must relate to the field existing at considerable elevations in the solar atmosphere, which may differ greatly in intensity, and may even be opposed in sign, to the field produced by the rotation of the body of the sun lying within the photosphere. Furthermore, since the sign of the charge of the outflowing electrons must be assumed, and since this sign may not always be the same, no certain conclusion can be reached as to the polarity of the general field or the sign of the charge that may produce it, even when the velocity of the electrons is accurately known.

METHOD OF OBSERVATION.

The observations were begun in 1908 with the 30-foot spectrograph of the 60-foot tower telescope. This instrument served admirably for the strong magnetic fields (maximum strength about 4500 gauss) in sun-spots, but the polarizing apparatus was not well adapted for an investigation of extremely weak fields. Certain minute displacements of the solar lines, such as would have been caused by a general magnetic field, were found on measuring the photographs, but these were not such as to command confidence, and further work was deferred until better polarizing apparatus should become available. The great solar activity at that time, giving rise to strong magnetic fields in sun-spots and their neighborhood, was another adverse factor. During the present minimum of activity sun-spots and other disturbances are rarely observed, and the unusually quiet condition of the solar atmosphere is precisely what is needed for an investigation of this nature.

Let us assume the sun's magnetic field to be similar to that of a magnetized sphere, with magnetic poles corresponding in position with the poles of rotation. The lines of force would then appear as in Fig. 10, the angle δ between them and the solar surface being given by the expression

$$\tan \delta = 2\mu \tan \varphi$$

when φ is the heliocentric latitude. If the field were strong enough, and if the observer could look along the

sun's axis and form an image of the one of the magnetic poles on the slit of a powerful spectrograph, he would find certain solar lines split into doublets, with components circularly polarized in opposite directions. If a Nicol prism were placed in front of the slit of the spectrograph with its long axis parallel to the slit in

this to be extinguished and the violet component to be transmitted. Consequently, if the quarter-wave plate were built up of mica strips 2 millimeters wide, mounted so that the principal sections of successive strips make an angle of 45 degrees with the slit and 90 degrees with each other, the Nicol would transmit (say) the red component for the odd strips and the violet component for the even strips. In a photograph of the spectrum the lines would have a dentated appearance, the magnitude of the separation of the components shown on successive strips varying directly with the strength of the field. If, from the same place of observation, the slit of the spectrograph were directed, not at the sun's pole, but at a point in 45 degrees latitude, the effect would still be clearly observable, though the transformation of the circularly polarized light of the components into elliptically polarized light would result in less complete extinction by the Nicol.

In practice, on account of the weakness of the sun's magnetic field as compared with the fields of sun-spots, complete separation into doublets is not to be expected. Moreover, the terrestrial observer, who is close to the plane of the sun's equator, must look in a direction nearly at right angles to the lines of force at the sun's poles. Thus he cannot take full advantage of the fact that the total intensity of the sun's magnetization is twice as great at the poles as at the equator. Fortunately, however, the angle between the lines of force and the line of sight (for an observer in the plane of the solar equator) is reduced to zero at 35 degrees north or south latitude. But the most favorable position for observation is latitude 45 degrees, where the effect of the ellipticity of the light of the components is overcome by the increased strength of the field. It was hoped that in this latitude a spectrograph of very high dispersion might reveal slight shifts of the lines, caused by the extinction of the red and violet components by the successive strips of the quarter-wave plate.

When a source of light is between the poles of a magnet, and one of its components (observed along the lines of force) is cut off by a quarter-wave plate and Nicol, reversal of the current through the magnet extinguishes the visible component and causes the other to appear. Hence, in the case of the sun's general field, the sign of the displacement should be reversed in passing from the northern to the southern hemisphere, on account of the change of polarity.

The investigation was resumed in October, 1911, with the polarizing apparatus described above mounted over the slit of the 30-foot spectrograph of the 60-foot tower



Fig. 7.—Polarimeter used for measuring the elliptical polarization produced by the celeostat mirror and second flat. The polarizing apparatus is mounted on the base of the instrument in position for tests.

combination with a quarter-wave plate set with its principal section at an angle of 45 degrees, one of the components of the magnetic doublets would be extinguished while the other would be transmitted by the Nicol, as in the case of a sun-spot. Assuming the red component to be transmitted, rotation of the quarter-wave plate through an angle of 90 degrees would cause

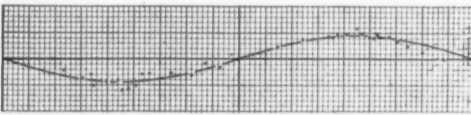


Fig. 9.—Mean curve of displacements including λ 5930 from first and third series and $\lambda\lambda$ 5812 and 5128 from fourth series of observation. The fully drawn out line represents the curve calculated according to theory, on the assumption that the effect observed is due to the general magnetism of the sun, with magnetic poles coinciding with poles of rotation.

Vertical scale: 1 division = 0.001 millimeter.



Fig. 8.—Excellent photograph of the solar corona, obtained at Yerkes Observatory on May 28th, 1900.

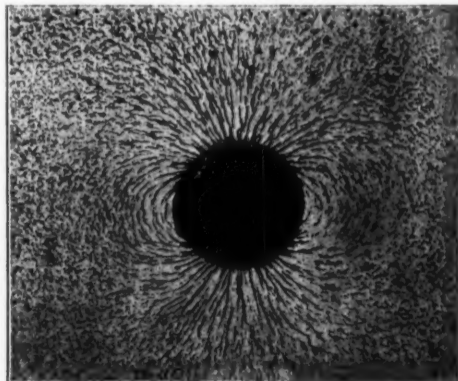


Fig. 10.—Lines of force of a magnetized sphere. Note resemblance to solar corona, Fig. 8.

telescope, but no displacements which could safely be attributed to the sun's field were detected. Fortunately, the completion of the 75-foot spectrograph of the 150-foot tower telescope soon provided a much more powerful instrument, especially adapted for this investigation.

A cœlostât mounted at the summit of a tower 164 feet (50 meters) in height sends a beam of sunlight to a second mirror, from which it is reflected vertically downward to an objective of 150 feet (45.7 meters) focal length, which forms an image of the sun about 17 inches (43 centimeters) in diameter in the laboratory at the base of the tower. The slit of the spectrograph, on which the image falls, is about 3 feet (0.9 meter) above the floor (Fig. 1). After passing through the slit, the light descends to the collimating lens of 75 feet (22.9 meters) focal length, mounted near the bottom of a well about 80 feet (24.4 meters) deep, excavated in the earth beneath the tower. Below this lens, in a suitable mounting, is a large Michelson grating of very high resolving power (about 622 lines to the millimeter, available ruled surface 67×126 millimeters). After falling on the grating the light is returned through the collimating lens, which thus serves also as a camera-objective, and forms an image of the spectrum on a plate mounted close beside the slit of the spectrograph. In a single exposure a portion of the spectrum 40 inches (1 meter) long can be photographed.

The first photograph of the solar spectrum made with this spectrograph in January, 1912, showed that a very high degree of precision might be expected in measurements of the positions of the solar lines. In the third-order spectrum, where much of the work described in this paper has been done, the scale at λ 5900 is 1 Angström=4.9 millimeters (Fig. 3). On this scale the distance between the D_1 and D_2 lines of the solar spectrum is 29 millimeters. An excellent test of the resolving power of the instrument is afforded by the exceedingly fine lines in the absorption spectrum of iodine, obtained by inserting a glass globe containing iodine vapor in the path of the solar beam (Fig. 4). Near λ 5458 is a pair barely resolved photographically, having a measured separation of 0.025 Angström.

The polarizing apparatus, which forms so vital a part of the equipment required for the study of the sun's magnetic field, is illustrated in Figs. 2, 5, 6, and 7. The general features of its design have been described above. The Nicol prism, 18 millimeters wide, built up by Verlein of four sections each 32.5 millimeters long so as to give a total length of 130 millimeters, is supported just above the slit of the spectrograph (Fig. 5). The junctions of the sections are necessarily marked in the spectrum by longitudinal bands (one of these appears in Fig. 3), but as a spectrum 90 millimeters wide can be photographed in a single exposure, the loss of measurable area caused by the composite structure of the Nicol is very small. If for any reason it becomes important to eliminate these longitudinal bands, this can be done by moving the Nicol prism back and forth, along the slit, during the exposure. Mechanism is provided to accomplish this, but for the purposes of the present investigation the Nicol is kept at rest, as it is important that the illumination of the grating should remain absolutely unchanged while each exposure is in progress.

For spectroscopic purposes, this long Nicol is even superior to a Nicol of the usual form, and of equal aperture (if such could be obtained). Its small thickness (8 millimeters) is a very decided advantage, and the impossibility of rotating it is easily overcome by the use of a half-wave plate, which can be mounted immediately above the Nicol (Fig. 6). Rotation of the half-wave plate through a given angle is equivalent to rotation of the Nicol through twice the angle, and the illumination of the grating is much less likely to be affected when only the half-wave plate is turned. As this arrangement is designed mainly for use in the study of the magnetic fields of sun-spots, the aperture of the (circular) half-wave plate is only fifty millimeters, but a half-wave plate covering the whole length of the Nicol might easily be substituted for the smaller one. In place of the half-wave plate, or in conjunction with it, circular quarter-wave plates, or half-wave and quarter-wave plates divided along a diameter into halves with their principal sections intersecting at an angle of 90 degrees, may be employed. Such combinations are required for certain studies of sun-spot phenomena, but are unnecessary in the present work.

The compound quarter-wave plate, used for the investigation of the sun's magnetic field in conjunction with the Nicol, usually without the interposition of the half-wave plate, is shown in position for use (Fig. 2). The support in which it is mounted is so pivoted that it can be swung to one side (Figs. 5 and 6) when adjustments of the Nicol or half-wave plate are to be made. On account of the great focal length of the spectrograph, the distance of the compound quarter-wave plate from the Nicol (33 millimeters) is not sufficient to reduce materially the sharpness of the dividing lines between adjoining strips of spectra, as the photograph reproduced in Fig. 3 indicates.

The procedure followed in making photographs of spectra for the study of the sun's magnetic field is as follows: The Nicol prism and compound quarter-wave plate are mounted above the slit, and the grating is observed to see whether the illumination from the solar image is central and complete. A parallel-motion device for orientation and guiding, supported by a massive iron column rising from the spectrograph head, is then swung into position over the slit. This carries a glass disk, on which is engraved a circle, the axis of which is to coincide with the solar axis, while the equator and parallels provide a scale for the purpose of setting a certain "marked strip," near the center of the compound quarter-wave plate, at any desired latitude. The disk is first rotated in its support until the axis of the circle coincides accurately with the slit. The solar image is then moved in the direction of the diurnal motion by means of the electric quick motion of the cœlostât, and the spectrograph head is rotated until the sun's limb runs along the equator (drawn as a straight line at right angles to the axis) of the circle. The azimuth of the slit is given by a large position circle, reading by vernier to $1'$, engraved on the circumference of the spectrograph head. The tabulated position angle of the sun's axis for the date of observation is then the angle through which the spectrograph head must be turned in order to make the slit parallel to the sun's axis. The average error of orientation by this method does not exceed $15'$, and could easily be made less, if this were necessary.

The grating support at the bottom of the well is not connected with the spectrograph head, but mounted on an independent support, which is rotated in azimuth by means of an electric motor until a telescope on the spectrograph head indicates the correct circle reading. The lines of the grating are then parallel to the slit. The grating itself is next rotated by another electric motor, about an axis parallel to the rulings, until the desired part of the spectrum comes into view. For most of the work described in this paper the region of the second or third order including the lines λ 5812, λ 5828, and λ 5930 was the one photographed. The overlapping spectra are cut out by a screen which transmits the region less refrangible than λ 5800. If the illumination of the grating is still perfect, and the focal setting of the collimator-camera objective (obtained with the greatest precision by the aid of the iodine absorption spectrum) is adjusted (by electric motor), the spectrograph is ready for the exposure as soon as the plates are inserted. Seed "23" or Seed "Process" plates, of very fine grain, sensitized for the red by Wallace's method, are used for the region below λ 5800. It now remains to set the solar image in the proper position on the slit.

The orientation device is moved until the shadow of a wire, crossing the axis of the circle at the desired latitude, falls on the "marked strip" of the quarter-wave plate. This is easily accomplished without destroying the coincidence of the axis with the slit, by the aid of the parallel-motion support. It is then only necessary to move the solar image, with the electric motions of the cœlostât and second mirror, until it lies centrally within the circle, and to keep it there throughout the exposure. This amounts to about 20 minutes at λ 5900 in the third order, with a Seed "23" plate. The stability of the spectrograph, the constancy of temperature at the grating level, and the optical perfection of the air within the well are sufficiently indicated by the high resolution of the iodine absorption spectrum (Fig. 4) photographed in the third order on a "Process" plate with an exposure of 35 minutes.

At λ 5900 in the third order the effective aperture of the spectrograph is 126 millimeters, while its focal length is 22.9 meters. Hence the ratio is 1/181. In the tower telescope two visual objectives, each of 12 inches (30.5 centimeters) aperture, but of different focal lengths, have been used to form the solar image on the slit. For the first of these the focal length is 60 feet (18.3 meters), and the ratio 1/60. The corresponding diameter of the solar image is about 17 centimeters. The second objective has a focal length of nearly 150 feet (45.7 meters), and gives a solar image about 43 centimeters in diameter. The ratio of 1/150 indicates that the circle of light from a short slit is 152 millimeters in diameter on the spectrograph objective (taking no account of diffraction), and hence more than sufficient to fill the grating. An objective of 30 feet (9.1 meters) focal length was also used for a time, but the solar image was too small for satisfactory measures in the higher latitudes.

It will be observed that the greatest source of error in the comparison of the spectra of different light-sources, namely the displacement of lines caused by differences in the illumination of the grating, is not to be feared in the present investigation. Nevertheless, although the method is purely differential, the adjustments were made with the same care needed in other classes of work.

For the preliminary investigation it was thought best to obtain a large number of measures of a few lines, rather than a smaller number of measures of many lines.

If the results were found to indicate beyond reasonable doubt that the displacement should be attributed to the Zeeman effect, the inclusion of other lines would naturally follow. The three lines showing the largest displacements, λ 5812.139 (Fe, o), λ 5828.097 (—, o), and λ 5929.898 (Fe, 2) were accordingly selected for systematic investigation at various latitudes in both hemispheres of the sun.²

HYPOTHESIS OF LOCAL WHIRLS.

The evidence furnished by the observations made seems sufficient to prove that the observed displacements are caused by magnetic fields in the sun. We may next consider whether these fields are due to local phenomena or represent the magnetic effect of a rotating sphere. We know that sun-spots always show the Zeeman effect, and that the widening of the lines frequently extends beyond the boundary of the penumbra. Magnetic fields may also be caused by invisible spots or by whirls in which no umbrae or penumbrae have appeared, if we may judge from the structure frequently presented by the H_α flocculi. Finally, there is some evidence to support the view that the pores are small vortices, which develop into spots under favorable conditions. Is it possible that the observed displacements are due to any of these causes?

I believe that we may answer this question without hesitation in the negative for the following reasons:

1. Our observations of sun-spots indicate that right-handed and left-handed whirls are about equally common in the northern and southern hemispheres. The great majority of spots consist of two principal members, frequently attended by satellites, the line joining the chief spots usually making a small angle with the solar equator. In general, I find these groups to be of the bipolar type, i.e., the two principal spots are of opposite polarity. When a new spot appears, it is very frequently double, and of the bipolar type. Hence there is no reason to suppose that the influence of spots, visible or invisible, incipient or disintegrating, could be of such a character as to produce Zeeman displacements which, on the average, are of opposite sign in the northern and southern hemispheres.

2. The observations have been made during a low minimum of solar activity, and in the great majority of cases no spots whatever, and few K^2 flocculi, were visible on the sun.

3. If the pores are electric vortices, like the spots, there is no reason to suppose that pores of one polarity preponderate in the northern hemisphere, and those of opposite polarity in the southern.

4. Even if there were a clear preponderance of pores of opposite sign north and south of the equator, it would be difficult to account for such a curve of displacements as the plotted observations represent. (See Fig. 9).

5. Assuming, however, that such a curve could be plausibly explained as originating in the pores, it is evident from the character of the curve that we should be dealing with a general magnetic field of the sun, though not one caused by the solar rotation.

SIGN OF THE DOMINANT CHARGE AND POLARITY OF THE SUN.

We have seen that within the limits of precision, the observations agree satisfactorily with the curve representing the displacements of a normal Zeeman triplet originating in a source on the surface of a magnetized sphere, and observed from a point in or near the plane of its equator. The curve is approximate, since it takes no account of a number of possible sources of error. It may be shown, however, that the errors arising from these sources would be too small to be appreciable in the case of observations of the present degree of precision. Thus the results are in harmony with the conclusion that the sun is a magnetized sphere.

Disregarding, for the reasons already stated, the hypothesis of local whirls, we are led to seek the source of the sun's magnetism in its axial rotation. We may first inquire as to the sign of the dominant charge, on the assumption that the field is due to the rotation of a charged body or a body composed of neutral molecules which act as though they carried a charge. The observations show that in the northern hemisphere the light of the violet component of the line widened by the field is circularly polarized in the right-handed direction. In looking at the north pole of the sun, the direction of the solar rotation is left-handed. As pointed out by König and Cornu, the violet component of a magnetic doublet, observed in the direction of the lines of force (current flowing right-handedly through the coils of the magnet), is circularly polarized in the right-handed direction. Hence the sign of the dominant solar charge would be negative (opposite to that of the current through the magnet), and the polarity of the sun must correspond with that of the earth. Thus the north magnetic pole of the sun lies at or near the north pole of rotation. The strength of the sun's field, calculated from the observations made, is found to be of the order of 50 gaussas at the poles. It will be remembered that the strength of the earth's field is gaussas.

² We omit here the detailed record of observations, for which the reader must be referred to the original.

Character in Handwriting

The Influence of Temporary Moods

By William Leslie French

In the pages of the SCIENTIFIC AMERICAN for this week some of the general principles of graphology, the science of reading character from a person's handwriting, have been explained and illustrated by examples. I shall here add a few supplementary remarks, taking up a special phase of the subject.

It is sometimes objected that graphology cannot give correct indications of a person's character, since one man's writing will often change from day to day and from moment to moment. This is not a valid objection. Changes in writing correspond to changes in mood or physical condition. This is well illustrated by the examples shown in the accompanying illustrations, which show a number of specimens of handwriting from the pen of the same individual.

Specimen 1.—Irritable temper—at least erratic—is found in the first "t" bar, while the dash in the second shows the opposite. The third indicates none.

Specimen 2.—The writing of a man finely poised mentally, the connections well made, showing logic. Concentration appears in the height of small letters. His emotions do not lead him very far astray, the writing being upright. See how he changed when he began to worry. He has heard some bad news, which in consequence causes him to let his script relax and run down hill, while he changes his slope to the right, showing that his feelings are affected. Naturally cool, he changes for the moment. (Specimen 3.)

Specimen 4.—Reveals that he has recovered his poise; this is toward the end of the letter. He crosses his "t" firmly as if to say, "Hold your emotions in check."

Specimen 5.—His connecting strokes are original in

this, while he sharpens the "u," giving a scientific bent and critical power.

Specimen 6.—Contrast the wide spaces between letters and words in Specimen 3 with this, and the result will be that the individual is generous and liberal at one time, and the opposite at another. The letters here are closely crowded together!

Specimen 7.—The capital "D" signifies conceit, self-importance and a love of display. The capital "M" in "mother" (Specimen 3) shows only a moderate amount. This softens this man's idea of himself to some degree.

Specimen 8.—The base line is straight—honesty and sincerity.

Specimen 9.—The base line waves with the letters at different angles—changeableness, insincerity and deviousness. Hence, the writer will lie to suit his convenience, being only honest occasionally. His writing in Specimen A shows a calculating spirit, being upright.

Specimen 10.—The peculiar nervous tremor, here and there, signifies that he is in abnormal condition, which he may not realize. His mind works by fits and starts, also shown by the enlarging of some of the small letters.

Specimen 11.—The curves at the bottom of the letters, rounded, give a love of music, melody and harmony. His power of concentration in the small letters would indicate that he would undoubtedly develop himself along this line if he had the opportunity.

Specimen 12.—The shading in this capital—"P"—shows a love of color. Its shape also denotes that he has artistic ability. It gives no information as regards music.

Specimen 13.—The word "you" shows a lack of music,

but the down shading gives only a material way of living. Therefore, this man's pen-use in this particular has very little value, it being over-shadowed by the other signs. He actually has both musical talent and a gift for design.

Specimen 14.—The high looping of the "f" in "from" shows a big imagination, which does not appear in the looped stroke of the "h."

Specimen 15.—There are no evidences of imagination in the "J" of "June." The former loop is in preponderance. He has a virile imagination.

Specimen 16.—Now, the heavy pressure seen throughout indicates, in a measure, will power, helped by his "t" crossings; but he is endowed naturally with a strong constitution, shown by the "y"-extension stroke below the line being rounded. This gives him physical power of recuperation and helps him to be more or less in control of himself.

Summary.—This individual is logical at times, changeable, vacillating, physically strong, but nervously weak. He is artistic, musical, vain, and self-conscious. His emotions play too important a part; he is swayed by them at one moment, and then absolutely cold. He swings from the right to the left as regards selfishness. He is moderately truthful. His mental powers, though acting spasmodically, are strong.

These few illustrations show to what extent the laws governing this subject can be applied. It is to my mind the most conclusive source of information concerning the mental, moral, and physical tendencies of human beings, and becomes a bulwark of protection for everyone, no matter in what walk of life they operate.

date. that visit

Specimen 1.—Varying "t" bars indicating erratic temper.

Your favor of recent

Specimen 2.—Good mental poise, emotions well controlled.

mother has recovered. I have just

Specimen 3.—The downward slope of the word recovered indicates passing despondency.

Specimen 4.—The writer has recovered his poise.

you say—

Specimen 5.—Critical power is shown.

received

Specimen 6.—Close spacing, a sign of parsimony.

received

Specimen 7.—Conceit and love of display.

the time

Specimen 8.—Honesty is here shown.

sincerely,

Specimen 9.—Not so honest here.

Thank

Specimen 10.—Nervousness.

dearest

Specimen 11.—Love of music.

P

Specimen 12.—Love of color.

you

Specimen 13.—Here no musical taste is displayed.

hear from

Specimen 14.—Imagination.

June

Specimen 15.—Imagination not shown.

your

Specimen 16.—Will power and strong constitution.

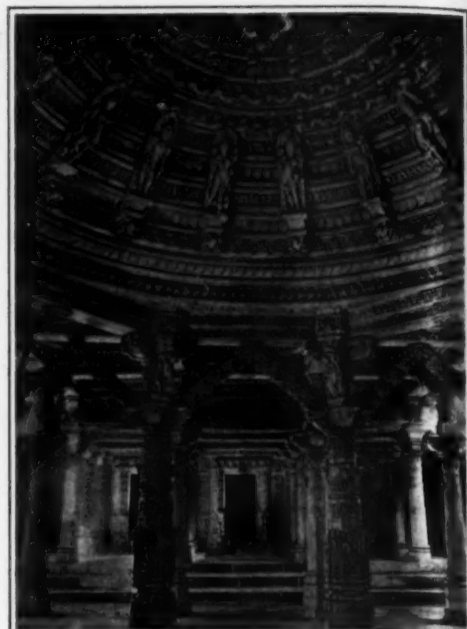
Fragments of a single letter, showing that a written document must be judged as a composite if the character of the writer is to be read correctly.



Beautiful and delicately carved marble columns and arches.



Fine artistic effect produced by arches leading to doorway.



White marble dome and portico. Note exquisite carving and graceful figures.

Temples of Dilwara on Mount Abu

Exquisite Examples of East Indian Architectural Art

By T. G. Dalal

THE religious zeal of every nation, sect and creed has from very ancient times, found expression in monuments of the building art exhibited in their best forms in the shape of churches, *Mandirs* (Temples), Pagodas, etc., in all parts of the world. This form of devotion towards the Creator, besides fulfilling its prime purpose, and perpetuating the name of the donor, individual or communal, also serves at all times to remind the world at large of the ages that have passed and the arts that have prevailed in their varying degrees from time to time. India contains many such exquisite relics of the spiritual soul of a nation, and probably the best of these is to be found on the holy Hill of Arbuda (Mount Abu), which takes its name from a serpent god of that name, who, according to the Hindu scriptures carried on his back Nandivardhan, the son of the mighty Himachal (The Himalaya Mountains) to this place, a distance of 700 miles, to fill up a deep and huge fissure that had occurred in this region. The modernized educated Hindu discards this theory and regards it (and probably correctly too) merely as an allegory suggesting the occurrence of a great earthquake which resulted in the creation of the Hill of Abu, though this he says much to the annoyance and displeasure of his orthodox and devout brethren of whom there is still a large number.

The *Dilwara Temples* on Mount Abu (Rajputana, India), belong to the wealthy Jain community of India, whose religious principles have much in common with those of Buddhism. Mercy towards all objects animate is the Jain's principal doctrine, so much so that the Jain priest would keep almost at all times a piece of cloth tied over his mouth lest he may not in his breath kill the minute germs that move about in the air, and he would not wear shoes, for fear of trampling the poor ant or a worm. He would visit as many ants' holes as possible every morning, and sprinkle a handful of flour on each, which the ants would quickly carry to their depository. Treat as we may all this as foolish, the Jain unquestionably believes that the prosperity of his race (and certainly they are the richest of all the many communities of India) is due principally to the motto of love and mercy towards all creation which their religion teaches.

Briefly the Jain tenets may be thus summarized, (1) They deny the divine origin of the ancient Hindu Sacred books. (2) Tenderness to every form of animal life is an essential dogma (this they share with Buddhists). (3) Life is without end or beginning, eternal endowed with the attributes of its own agent and enjoyer, conscious and subtle, and proportionate to the size of the material body it animates, expanding with the elephant and contracting with the gnat. This 'Life' is condemned by sin to pass into a lower form of animal existence or to hell, while by the annihilation of all vice and practising virtue, it receives 'Moksha', i.e., emancipation. (4) Their practical religion consists in reverence for 24 deified men, formerly teachers, who by lives of

great austerity, have obtained this final emancipation.

The *Dilwara group* consists of four temples, each with its subsidiary shrines and corridors standing within its own enclosed quadrangle, each about 100 feet square. Among all this lavish display from the sculptor's chisel, two temples, viz., those of Adinath and Nemnath



Gau Mukh (cow's mouth) stream, with delightful jungle scenery, Mount Abu (Rajputana, India).

stand out as pre-eminent and especially deserving of notice and praise, both being entirely of white marble, and carved with all the delicacy and richness of ornament which the resources of Indian art at the time of their creation could devise. The amount of ornamental detail spread over these structures in the minutely carved decoration of ceilings, doorways, pillars, panels and niches is simply marvelous, while the crisp, thin translucent, shell-like treatment of the marble surpasses anything seen elsewhere, and some of the designs are just dreams of beauty. The general plan of the Temples, too, with their recesses and corridors lends itself very happily in bright weather to varied effects of light and shade with every change in the Sun's position. The numerous designs are free and varied, and not a corner, not a slab, is left uncarved, the architect having put his whole

soul and brain into the work, while expense appears to have been no consideration to the founders of the Temples.

As regards the general style of the architecture, all known examples of Buddhist arches are generally copies of wooden forms. In the *Dilwara Jain Temples* however one sees the true arch, but the arches and domes are not made as we are accustomed to see them in our buildings, with radiating voussoirs, but by horizontal layers of stones. This form was also used by the old Greeks a well known example being the tomb of Atreus at Mycenae.

The Hindu could never reconcile himself to the 'Visviva' of the radiating arch with its destructive lateral thrust; such an arch "never sleeps" they say; they however carried this theme to extremes, often using the horizontal arch where the radiating form would have been better. In the dome however the horizontality confers great advantages, and admits of the easy introduction of those delicate pendants which form such a beautiful feature of the style. Such an ornament introduced into a dome built radially, necessitates the addition of strong abutments to resist the increased thrust, whereas in this case it simply adds its weight to that of the dome.

Another advantage will be at once seen from the illustrations given: All the ornamentation is arranged in rings concentrically instead of radially. This allows of infinitely greater variety, a feature that, it will be noticed, has been taken every advantage of in the *Dilwara Temples*. The pillar-supported dome with its curiously beautiful and delicate struts is another peculiarity of this style, and the possibilities of which the grouping of the pillars allows will at once strike the eye.

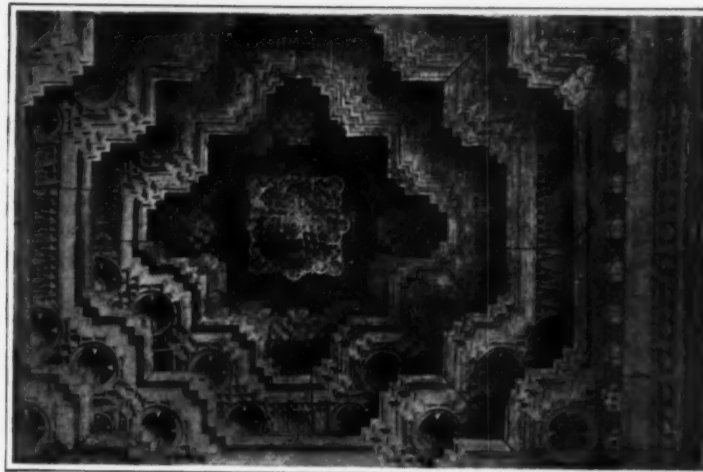
The first Temple is that dedicated to the Jain Tirthanker (Saint) Adinath, and was constructed in A. D. 1032 by Vimalasah, a viceroy of the King of Gujrat. It is said to have cost \$62,000,000 and to have taken 14 years to build. The dome in the center with its circular rims and richly carved pendant forms the most striking and beautiful feature of the entire composition. The subtlety of the carved work is marvelous, and the forms are full of life and action, while the delicacy and workmanship of the carved strut springing from the bracket capital and meeting the architrave in the center is admirable.

Round the quadrangle are 52 cells containing images of the several Jain Tirthankers, while the ceilings of the porticos in front of the cells are very elaborately carved, illustrating tales from the various Hindu scriptures, for instance the 'Lila' or sports of the youthful deity Krishna with the various goddesses, the Narasinha ("Man-lion") Avatar, being the fourth incarnation of Vishnu, the Gandharvas ("Musicians of heaven") with human torsos and peacocks' tails, etc.

The second temple was constructed in A. D. 1231 in honor of the Tirthanker Nemnath. The design and execution of this shrine and all its accessories are on the



Exquisitely carved central dome representing a lotus.



Carved ceiling of a portico, depicting a Vav (small tank).

model of the preceding, which, however, as a whole it surpasses. It has more simple majesty, the fluted columns sustaining the Mandap (portico) are loftier, and the vaulted interior is fully equal to the other in richness of sculpture and superior to it in execution, which is more free and in finer taste.

The dome in the center is the most striking feature and a magnificent piece of work, and has a pendant cylindrical in form and about 3 feet in length, that is a perfect gem, and which, where it drops from the ceiling, appears like a cluster of the half disclosed lotus, whose cups are so thin, so transparent, and so accurately wrought that it fixes the eyes in admiration. It hangs from the center more like a lustre of crystal drops than a solid mass of marble, and is finished with a delicacy of detail and appropriateness of ornament which is probably unsurpassed by any similar example to be found

anywhere else. The quadrangle in this temple contains 42 cells with one or more images of the Tirthankars placed therein with their bejeweled eyes and expressionless faces. The design of the ceilings of the porticos facing these cells are diverse and beautiful, and contain among others scenes from the life of Nemnath the Tirthanker, his marriage, deification, etc.; an army starting out, the fight, return of the victors, and then rest at home with horses in their stalls and cattle in their pens; a miniature Vav (small tank) with its graceful tiers of steps geometrically faultless and full of excellent workmanship.

In the space of this short article it is difficult to fully describe all the exuberant beauties of this proud monument of India's art at its best, but suffice it to say that the Dilwara temples on Mount Abu are "One of the best sights in the world," as the writer has often heard from

the mouth of many an American and English tourist visiting the station, while according to Colonel Tod, the great historian, "beyond controversy this is the most superb of all the temples of India, and there is not an edifice besides the Taj Mahal (at Agra) that can equal it."

Besides the wonderful Temples, Mount Abu has many other attractions for the Tourist through India, in that it is an excellent resting place for travelers, its salubrious climate being most appreciable. The other sights of the station are *The Nakki (Gem) Lake*, which some one has compared to "The Lake 3 miles above Andernach on the Rhine." The *Gau Mukh* Temples through thick forest with its enchanting scenery where a spring of clear water passes day and night into a small tank; the Achalgarh ancient Fort and Temples 1,000 years old with the most picturesque hill scenery *en route*, Arbuda Devi, Trevor Tal, etc., etc.

Letters Patent in Relation to Modern Industrial Conditions—I*

Adequate Patent Protection an Absolute Necessity for Progress

By Frederick P. Fish

THE present is a critical period in the industrial history of the United States. We are at the burning of the ways. For more than a hundred years industrial progress was the great ambition of our people. Material development was preeminently their ideal. Our wonderful progress towards the end of the nineteenth century excited, throughout the nation, the greatest enthusiasm and satisfaction. The public had shown its sympathy with industrial expansion by deeds as well as by words. The nation, the states, municipalities and individuals, had all worked together to secure as rapid expansion as possible. The building of transportation systems, large and small, was everywhere urged and was cordially promoted by governmental grants and by pledge of the credit of states and counties. Free land and remission of taxes for long terms of years were promised by municipalities and townships to any industry that was established within their borders. Money was liberally contributed for the same purpose. Public franchises were freely granted and extremely liberal corporation laws were adopted without dissent, to make it easy for our industries to obtain capital and to grow. Our protective tariff was a popular national institution because the people were persuaded that it operated to develop our manufactures. Foresight and capacity in business affairs were universally regarded as the most admirable of all qualities, for they contributed to the development of the national ideal. The Captains of industry were among our great national figures.

This point of view prevailed until a few years ago when a change occurred in public sentiment. It began to be recognized that our extraordinary industrial development might not be altogether ideal in character and in its relation to society. As the result of criticism, increasing from year to year, some of it well-founded, but much of it, even when sincere, based upon a want of appreciation of the inherent difficulties and complexities of the situation, a reaction followed which has not yet run its course. At the present time there is but little left of the popular enthusiasm for our industrial successes which was so universal twenty years ago. Prevailing business methods are the subject of attack and many features of industrial organization which are most characteristic of modern conditions are regarded with suspicion. The reflection of the attitude of the public

in legislative bodies and courts has resulted in a policy which is by no means friendly to business as it is carried on and which may make further industrial progress difficult, at least until our industries and those who direct them have learned how to adjust themselves to the new conditions of popular thought. I call attention to this matter at the very beginning of this paper to emphasize the proposition that in dealing with the subject of the patent system of the United States and the wisdom of the laws under which it is established and maintained there is no room for partisanship or prejudice. Whatever may be the views of those who think fairly upon the subject as to the propriety of a protective tariff, the powers to be given corporations and as to the extent and character of the control that should be exercised over large enterprises, or as to the necessity of reform in business methods, whatever may be the popular feeling as to the distribution of wealth that arises from our present social and industrial institutions, questions as to the value and importance of a patent system and as to the spirit in which it should be organized and administered are in fact and should be regarded as entirely independent of all such considerations.

THE PERFECT REWARD FOR INVENTION

No one doubts that industrial prosperity is essential to the welfare of the community. Those who are to-day most critical of our business methods, of our great business organizations, and, generally, of the relation between business and society are just as anxious for industrial prosperity as were the enthusiasts of twenty years ago whose admiration for our industrial conditions was unbounded. If it is clear that a liberal patent system is essential to industrial development, all must favor it, whatever side they may take in the acute controversies of the day. If that of the United States not only has definitely promoted our welfare in the past, but, because of its merit, its fitness to encourage invention and there promote the useful arts, is likely to be of equal or greater value in the future, it should receive unanimous support. Its importance to our national well-being is equally great, whatever may be our business methods, the form or spirit of our industrial organization or its relation to our society. It is true that our patent system has largely contributed to the development of our industries, great as well as small, with all their characteristic features, whatever they may be. So have our natural resources and the ability of our workmen and of our

industrial leaders. But no one complains because nature has bountifully provided us with the opportunities for great productive capacity and everyone is anxious that our people should be, individually and collectively, more efficient. In like manner all must agree that the stimulation of invention and of the inclination to develop invention is a matter of prime necessity and altogether unobjectionable even if it is in part responsible for the conditions as to which complaint is made.

It hardly seems necessary at this stage of industrial history to advance arguments in favor of an adequate patent system as an effective and as far as can be seen the only practicable stimulant for the promotion of the useful arts that can be given by the community. For many generations it has been generally agreed that a definite and attractive reward was essential if inventions were to be made and introduced into use. Experience has demonstrated that no form of reward so fitted the achievement, was so productive of advantage to the community and was attended by so few advantages as the grant to an inventor of a monopoly of his invention for a limited time. While many other forms of reward have been suggested (such suggestions were made at the convention which adopted our national constitution), they have nowhere been adopted as part of the machinery of society. Everywhere some form of exclusive control for a limited time has been recognized as the best way of dealing with the matter.

The encouragement of patent protection does not alone stimulate the inventor to intellectual effort; it excites to strenuous endeavor a long line of intermediaries, capitalists, investors, business administrators, licensees and users who work with or under the patent and whose co-operation is vitally necessary that the invention may not be confined to a paper description, but may actually be used.

After all this line of public servants has been rewarded, the ultimate consumers get their advantage from the invention, even during the term of the patent, in the form of less cost, added facilities, increased comfort and greater convenience; and their gain, while the patent is in force, is undoubtedly in almost every case infinitely greater than that of those who profit directly from working under the patent. Of course when the patent expires the invention is free to all.

This form of reward is strictly automatic. It only comes to those who meet a public need by giving to the

* Paper read before the American Bar Association at Montreal, on September 2nd, 1913.

community something that it desires and will use. Any other that can be suggested would surely be arbitrary. No other plan could be devised which, as is the case with patent protection, rewards the inventor and those who introduce the invention into use, substantially in exact proportion to their real contribution to the good of the community. This is what the reward by way of patent monopoly for a limited term effects and such reward is just and fair.

THE NEEDED STIMULUS FOR INVENTION

Letters patent for inventions are now granted by practically every one of the civilized nations of the world and by many of the less progressive nations. Until 1888 Switzerland had no patent law. As pointed out by Prof. Shaler in his book on the "Nature of Intellectual Property," published in 1878, it was argued that, situated as Switzerland was, in the heart of the industrial world, with a docile and intelligent population, trained by an admirable system of education, and with the great advantages by way of water-power which the country possessed, it could progress more rapidly if its citizens were all free to appropriate for the national industries the ideas, patented or unpatented, of the rest of the world, without the grant of any monopoly to individuals in Switzerland itself. This policy was, however, found to be short-sighted and ill-advised, as Prof. Shaler declared it to be. The Swiss were not encouraged to invent. More than that, they were not encouraged to adopt and introduce inventions. They did not develop the desire to improve. Because they had no patent system, their industries did not advance satisfactorily.

Under the stress of the necessity that invention should be fostered in the community, if industrial progress in competition with that in patent-granting countries was to be secured, a patent law was adopted in 1888. Since then there have been over fifty thousand patents issued in Switzerland and her industrial progress has been marked.

Holland in 1869, before the extraordinary expansion of the latter part of the last century had even begun, abolished her patent law, undoubtedly influenced by the hope that her situation was such as to make it more for her interest to take freely the inventions made anywhere outside of her own boundaries than to attempt to develop inventions and the inventive habit among her own people. It is significant, however, that she has, after trying the experiment for more than a generation, recognized its futility and has now again established a patent system.

Why is it that practically all countries grant patent monopolies? Switzerland and Holland found it necessary at this late day to adopt a policy the superficial effect of which is to grant exclusive rights for a limited term, not only to their own citizens who have made or who are promoting inventions, but to foreigners, rather than to attempt to develop the industries so vitally necessary to their well-being by leaving everyone free to appropriate all new ideas from within or without the country. The reason is clear. While industries necessarily exist in a country which has no patent system, and the people of that country may be industrious and intelligent, industrial progress is impossible unless the people of the country are as a whole stirred to inventive achievement and the aspiration for improvement; and for this the reward and stimulus of a liberal patent system is essential. Nothing can take its place.

The whole history of industrial development shows that it is only through the prospect of special gain that men will devote attention to inventing or to inventions. Without adequate hope of unusual returns neither the man of inventive capacity nor the business man and the capitalist can be induced to take the chances and go to the great trouble and expense necessary to work out inventions or to establish new industries or reorganize industrial methods so as to utilize inventions. As a class, they are wise enough to recognize that the chances of success are not so great as to justify the risk.

But if they are tempted by the definite promise that they shall control for a limited time a new process or an improvement in a machine or in the manufacture of a new article, they will cheerfully work, spend money and face the chance of disappointment and failure, first, because during the time of the patent monopoly their returns will be fixed by what the traffic will bear and not by destructive competition and, second, because during the term of the patent there is a chance to perfect manufacturing methods, to build up an enterprise or series of enterprises and to acquire a good will which will be of special value even after the patent has expired. Some men are, of course, more enterprising and more ready to take chances than others, but any man is far more likely to dare the risks of a novel enterprise and to institute and push a business that has in it marked elements of uncertainty, if, as owner, part owner or licensee, he can have temporary protection under a patent against the competition which without the patent he would have from the beginning.

Nowhere can it be worth while to invent, unless there is opportunity for utilizing inventions if made. Even

if every citizen were an Edison, it would not profit him to work out new ideas on paper or in a laboratory unless the conditions were such that they could be introduced into use with the chance of a proper return. The inventor therefore is helpless unless he has something to offer the manufacturer or the capitalist that will justify the latter in paying for rights to the invention. An adequate patent system gives to the inventor, who as a rule never could himself do anything with his invention, something that is tangible and of value, which he can transfer, in whole or in part, to the business enterprises which alone can make the invention of value to the community. Inventors, and business men who develop inventions and introduce them to the service of man, to exactly the same degree and for the same reasons are stimulated by the protection afforded by a patent, to efforts which they would never otherwise make. Each class would be helpless without the other. It is only when both are encouraged and protected, as they are by the grant of a patent, that the progress of the useful arts is promoted.

It is not always recognized how serious and difficult are the practical problems involved in invention, the reduction of inventions to practical form and the introduction of them into use.

Very few inventions are the result of a happy thought which comes without cost or expense and is complete and perfect at the time of its conception. Very few find a market ready made for them. In almost every case inventions are based on hard study followed by a long period of experimentation and designing which involve most vigorous effort, often misdirected before anything useful or tangible can be accomplished.

First of all, with most inventions large or small, there is the necessity of a clear recognition of the problem, that is to say, that there is opportunity for a new device or method or for the improvement of a device or method already in use. This requires exact knowledge and judgment of a high order. Careful, intelligent and often long continued study of the field may be required before even the nature of the problem is clear. Next comes the intellectual effort to solve the problem. Before success is attained, there is apt to be failure after failure with the waste of time and money involved in prosecuting a long series of fruitless experiments; and during all this period there is only the chance of real ultimate achievement to keep the inventor up to his work.

THE INDUCEMENT FOR DEVELOPING INVENTIONS

Why should any reasonable man spend his time in efforts of this character when the probabilities of failure are so great, if he has no assurance that he individually will have control of the product of his imagination and thought in case of success? When there was no patent system, an invention made by a Swiss or a Hollander, unless it could be kept as a trade secret, which in most cases was impossible, became immediately public property. The inventor, if himself in a business to which his improvement was applicable, could get no advantage from it as against his competitors. If, as is so often the case, he had no facilities for doing anything with his invention, or had not the capacity even to put it into practical form, he could offer no inducement to anyone to furnish the brains and money necessary to develop it and introduce it into use. Inventive effort was necessarily stifled under such conditions, and the stifling of inventive effort is a very serious matter. Not only does it destroy the possibility of that progress in the arts which is based upon radically new inventive ideas, but it incapacitates those who are engaged in the industries from the analogous intellectual effort required to make the mechanical improvements, not requiring invention, which are of such vital consequence. If the industrial workers of a nation are discouraged from inventing, they are not apt even to improve. They lack the training; they do not have the right habit of mind. On the other hand, if they are stimulated to invent, there is developed as an incident to inventing, the capacity and the instinct to make mechanical improvements, not amounting to invention, such as have proved to be of great value in the arts. Such improvements are the by products of the inventive habit.

Let us consider for a moment more definitely the situation and instinctive attitude of the manufacturer or of the investor or capitalist, large or small, whose part in the development of inventions is hardly second to that of the inventor, as the same is affected by the presence or absence of adequate patent protection.

It is seldom that an invention, even if of a high order, obtains any foothold in the industries merely because it has been conceived and described as, for example, in the specification of a patent. Its first embodiment is almost always crude and uncommercial. Often and perhaps generally the original inventor has not himself the capacity to give the right mechanical organization to his new ideas. In every direction further work is required which can only be carried on by the aid of capitalists and trained business men. Competent designing engineers and skilled mechanics must be employed at a large expense to put the invention into commercial form. Its

precise place in the art and its true relation to existing conditions must be determined. The direction in which it can be developed in order to meet the needs of the public must be found out. The best way to build up a market for it must be discovered and this is in many cases a problem of great difficulty. Often the new invention will displace devices or processes of manufacture which seem good enough to those who have them in use. Almost always its adoption will involve changes in the methods or in the shop or commercial practice of the prospective consumer which he will be disinclined to make. Machinery must be scrapped and workmen educated to new forms of activity before the invention can be employed. Selling methods must be modified and very likely entirely new plans of advertising devised. All this involves expense and trouble and the overcoming of inertia on the part of those who are solicited to adopt the invention.

Even if the invention meets a real demand there is frequently the opportunity and occasion for the expenditure of a vast amount of money and of the greatest intelligence and energy on the part of those who are introducing it into use before commercial success can be attained; and always there is the chance of utter failure.

Under these circumstances, neither in Switzerland or Holland, nor elsewhere, could capital be expected not take up and push new inventions under conditions, where, if success were achieved, the full benefit of the invention would necessarily be immediately shared by all competitors.

In fact, competitors would have a great advantage over the manufacturer or the capitalist who bore the brunt of the preliminary development. They would have borne no part of his burdens and expense but would, without cost, adopt from him the perfected thing to which he had devoted so much energy and in which he had made such a large investment. They would reap where he had sown. Under such conditions even the most brilliant inventor cannot get the help which he must have.

The effect of a sound patent system is to overcome these obstacles to the development of inventions, to encourage men to invent who would otherwise have very little reason for inventing and to attract business men to the arduous task of perfecting and introducing inventions when otherwise they would be inclined to leave them severely alone.

I do not believe that anyone who has given thought to the question can doubt that at the present time no great industrial progress can be expected in a country which does not offer patent protection to those who have it in their power to promote the progress of the useful arts, or fail to conclude that invention and the industrial development due to invention are in any country largely proportional to the extent to which the patent law of that country operates as an effective stimulant.

THE SUPERIORITY OF THE AMERICAN PATENT SYSTEM

The patent system of the United States has existed for nearly one hundred and twenty five years. During practically all of this period it has had the strong support not only of those who have understood and thought about the matter, but of the public generally, who believed in it and encouraged legislators and judges to establish and maintain it on broad and sound foundations. Only once, in the late seventies, and as part of the movement which resulted in populism and the doctrine of fiat money, has it been the subject of noticeable criticism. Even then our patent system would probably have escaped attack if it had not been that a considerable number of individuals had been annoyed, as they thought wrongfully, by the harsh enforcement of certain patents, such as that on the driven well and some of the barb wire fence patents. But when the matter was at that time brought before Congress it was clear that the people stood for the law as it was. No change was made and the episode was soon forgotten.

Now, again, Congress is considering the revision of the patent laws and in a hostile spirit, if the report to the House of Representatives of the so-called Oldfield Bill is an indication of the prevailing view.

It is significant that there is no evidence whatever of any public demand for a change in our patent law or the principles upon which it is based. There is a definite and widespread conviction that reforms are needed in the procedure both of the Patent Office and the courts. Nowhere, however, does there appear to be any real sentiment against the fundamentals of the law. The voluminous testimony taken before the Committee on Patents of the House of Representatives at its last session is most significant. A large number of manufacturers, patentees, lawyers, representatives of public organizations and others in touch with the subject were heard by the Committee. Practically no criticism of any moment was made by any of these witnesses on the underlying ideas or principles of our patent system or as to its beneficial effect upon our industries and our society. It is also to be noted that those who appeared before the Committee were almost unanimous in opposition to those provisions of the bill subsequently reported,

that were under consideration at the time of the hearing.

The patent system of the United States is, I think, generally recognized as more effective than any other for the purpose intended. It differs from the English system, which alone preceded it, and from that of most other patent-granting countries, in two important particulars. First: Letters patent for invention are granted in the United States only to the first inventor, to the man who himself definitely thought out the new conception. Under the English system and most others the reward of a patent is given to him who has introduced a new idea into the realm, whether he found it in some other country or himself originated it. The American patent law says, not only to citizens of the United States, but to the people of the world, "If any of you will think out an improvement in the useful arts and adequately describe it in a patent specification so that it becomes a part of the world's general knowledge and can be practised from the disclosure of the specifications, we will grant to you, under the terms of our constitution and laws, an exclusive right to control the invention for a limited period." It is the intellectual act of invention that is encouraged and rewarded. No consideration is given to the question whether a new industry or an improvement in an old one has, as a matter of fact, followed the invention. The framers of our constitution and the statesmen and jurists who established and maintained our patent law saw clearly that if invention, an intellectual effort, were sufficiently encouraged, as would be the case if the complete control of the invention for an adequate term rested in the patentee and those whom he could induce to cooperate with him in exploiting the invention, sound development and rapid improvement in the industrial arts would surely follow.

Second: as a corollary to this main idea our law provides that the control of the invention, by statute vested in the patentee for a limited period and which he may ultimately share with those who join him in working under his patent, shall be absolute and exclusive in a true sense and subject to no conditions.

Our American patentee has seventeen years of patent protection, during which he is free and untrammelled in his efforts to get a return from the invention.

In most foreign countries fees are to be paid every year or every few years and if not paid, the patent lapses. If there is not actual manufacture under the patent within a given short time, patent protection ceases. A compulsory license may be demanded of the patentee on terms not at all to his liking or under conditions that are fatal to his plans and hopes for working his patent to his own advantage.

It is generally recognized that of letters patent that are ever directly profitable to the inventor or to anyone else, and very many bring loss rather than gain, a great proportion, if not the majority, do not begin to bring in any appreciable return until the later years of the patent. Such being the case, the provisions of the patent laws of almost all foreign countries by which the patent becomes void, unless fees are paid from time to time or unless it is "worked" at an early date, and according to which the patentee's control may be destroyed by compulsory licenses, enforced against his will and interest, are undoubtedly most discouraging to inventors and to those who would cooperate with them.

The owner of a patent granted by the United States has none of these disadvantages. He has no fees to pay as a condition for the continuance of his rights. There is in our law no provision for "working" patents or for compulsory licenses. There is no obligation of any kind imposed upon the patent owner. He may deal as he pleases with his invention and his patent. He may or may not make any use of his invention. He may sell the whole or any part of his patent, for the entire country or for any given territory. He may grant licenses to one or more people to make or to use or to sell the invention, either or all. He may license some to use it for one purpose or under certain conditions, and others for a different purpose or under different conditions. He may refuse to license if he pleases. He may charge what he thinks proper by way of license fees or by way of price for articles made under the patent. That he may attach any conditions "not definitely illegal" (*Bement vs. Harrow Co.* 186 U. S. 70, 91) to any license is settled by the courts. (*Henry vs. Dick Co.*, 224 U. S. 1) except in so far as the recent decision in *Bauer vs. O'Donnell*, 229 U. S. 1, denies him the right to attach a condition to an article which has been sold for the full consideration which the patentee expects to receive.

THE PERILS OF "COMPULSORY LICENSE" AND WORKING CLAUSES

When we consider the chances of failure that inventors, capitalists, manufacturers and investors take and the trouble, expense, energy and intelligence required to bring a new idea or even an improvement into commercial use, involving, as is the case, extensive experiments before and after the invention is made, the determination of the exact field for the invention, the overthrowing of habits, the education of the consumer, the discovery of how he can be induced to take up the new invention,

and ultimately, in many instances, the scrapping of machinery and the modification of manufacturing methods, it would seem that the least encouragement adequate to keep men at such work would be an absolutely free hand for a short term of years, such as is given by the patent laws of the United States. There is no reason to believe that the present seventeen year patent term is excessive; If it is too long, shorten it, but do not hamper the patentee during the term. In far too many cases has seventeen years proved not long enough to enable the inventor, whose ideas were ahead of the times or who was not able to secure cooperation of the right kind, to get an adequate reward for his achievement. But even if, as some believe, inventors and those working under patents have, on the whole, expended more than they have made in their efforts to develop inventions, enough inventions have succeeded to give the necessary stimulus to the American people to make them a nation of inventors.

It is obvious that the standards and rules imposed by foreign patent laws as to working inventions, and as to the grant of compulsory licenses, are and must be purely arbitrary. Even if wrong in principle they might happen to operate reasonably well as to some inventions. But in so far as those provisions are effective at all, they must be fatally destructive in many cases; and no man who is inclined to invent or to promote invention can be sure that any particular invention will not be one of a class that is necessarily rendered unprofitable because the law fails to give him a free field for effort during the term of the patent.

It must not be forgotten that among the other burdens of one who is undertaking to exploit an invention of any value is that others immediately desire to use it, and will do so if they can. They may be able to develop something else that is equally advantageous for the same purpose. One feature of the greatest value in an adequate patent system is that every invention is at once known, because it is patented, and because if of any value it is likely soon to come into use. Knowledge of the invention whether gained from the patent or otherwise, immediately excites others to invent. An innumerable number of first-rate inventions would never have been made if there had not been an attempt or a series of attempts to meet a public demand by way of invention that got so far as to be patented but which proved not to be of final value. He who finally succeeded in giving to the public what it wanted is the one who is entitled to receive and who does in fact receive the credit and the reward, even if his efforts were excited and perhaps in part directed and shaped by the failure of others. In like manner a successful invention often leads to others which equal or excel it.

The effort to devise something new in order to compete with an invention already made is most commendable; but would-be competitors do not confine themselves to such legitimate activity. If they cannot evade the patent on technical grounds and the patentee does not regard it as for his interest to give them such a license as they want, they are sure to look to the "working" clause or the "compulsory license" clause of the patent law, if there are such provisions, to enable them to reap where they have not sown. Their influences and efforts, therefore, are altogether against the struggling patent owner whose attempts to comply with the obligation to work his invention they will nullify if they can and from whom they may get a compulsory license that will be fatal to his success.

After a somewhat careful investigation of the situation in foreign countries I am satisfied that the so-called working clauses and compulsory license clauses of foreign patent laws are hostile to the real public interest and that they operate greatly to the discouragement of invention and thereby distinctly stand in the way of the sound development of the useful arts. I believe that the simple provision of the United States patent law that after the grant of his patent the patent owner shall control the invention absolutely for a short but definite term, having no more payments to make and no fear of interference from competitors during the term, gives to our people a far greater stimulus to invention than does the law of any other country.

PATENTS AS A FACTOR IN AMERICAN CHARACTER

Certainly, for one reason or other, we have become a nation of inventors. It is almost a habit on the part of those in our country who are engaged in industrial pursuits to seek to improve the machinery and methods with which, respectively, they are familiar. Employees, from the highest grade to the wage-earner, are on the lookout for new ideas and new methods that will result in economy, increased production or the creation of new implements fit for the service of man.

The result has been that in almost every field of industry there have been inventions of the most striking character; but what is of no less importance the useful arts have been continuously promoted by an infinite number of smaller inventions which in the aggregate are very largely responsible for the efficiency of our modern industry. All this must be due almost altogether to the adequacy

of our patent system. No other explanation is even plausible. Certainly nothing in our climate or the character of our population can account for it. Moreover there is no nation which is so ready to promote inventions or to adopt them in practice as the United States. The entire community has recognized not only as a theory but as a practical matter that progress depended upon continuity of invention and has been ready freely to adopt new things, even at the sacrifice of tradition and of existing methods and appliances. Capital has been available for the development of inventions which were supposed to be new and useful to a greater extent than has been the case elsewhere. Manufacturers and investors generally have had the necessary encouragement to seek out and foster inventive faculty and to undertake freely the large expenditures and great administrative effort required for the prosecution of inventions through their experimental stage to practical and commercial success. Administrative energy and executive ability of the highest order have been eager to co-operate.

There is no doubt that the history has been in part one of failure. Many inventors have been disappointed and much capital has been expended without return because of the failure of inventions that seemed promising, for the reason that they proved to be without merit, because there was no immediate place for them in the industries, or because of difficulties in introducing them were found to be insuperable; but there have been great successes resulting in a rich reward to inventors, which have stimulated other inventors to increased effort, and returns to capital that have encouraged it to seek the field of invention as one that was most attractive. The failures, pathetic as they frequently are, are forgotten, but the successes appeal to the imagination of the community.

The result is that to-day there are not only a very large number of men struggling with inventive problems or who are on the lookout for the opportunity to invent, but the effort has been systematized in accordance with the scientific principles upon which modern business is carried on. With the large enterprises of the country invention is as much a part of the systematic organization of the business as manufacturing or selling. Intelligent men are employed to determine the problem of the business and to find in what direction improvements should be made that there may be extension into new fields, increased production, greater economy or an improved product. Highly trained engineers and inventors attack the problems as they are presented and work them out in well equipped laboratories where not only technical skill, but thorough scientific investigation, carried on almost regardless of expense, are applied to their solution. Meantime, as always, individuals, even the most humble, are inventing or hoping to invent.

They know that nothing is more likely to advance them in wealth and comfort than an invention, the opportunity for which is wide-open before them, reward in proportion to the merit of what they may accomplish, being almost more certain in this than in any other field of human endeavor.

(To be continued.)

The Radium Market

THERE has recently been a marked reduction in the prices of radium preparations. Earlier in the year radium bromide sold for \$105.60 per milligram in Germany; and, in April, a New York firm offered for sale any part of 800 milligrams of radium bromide, gauging from 25 per cent to 90 per cent purity, to be delivered in tubes of 10 to 125 milligrams capacity, at \$90 to \$100 per milligram. In July, however, the K. K. Montan-Gesellschaft in Wien, which produces radium salts from pitchblende, made sales at \$43.20 to \$52.80 per milligram, depending upon the activity. The recent decrease in price is thus explained in *Chemie*, 6, No. 1530: During the last three years, mesothorium, as well as radiothorium, began to be employed in place of radium, especially in medicine. Mesothorium is obtainable at a cost of \$32.40 per milligram in Germany and, in addition, may be procured four times more active than radium. While the life of mesothorium is short, by mixing it with radium salts a preparation of long life may be obtained. The total production of radium bromide per year is between 2 and 3 grams. In 1911, the radium preparations produced by the Austrian Radium-präparatfabrik amounted to 14.146 grams, containing 2.647 grams of pure radium chloride, valued at \$214,900.

The Radium Hill Company conducted operations in 1912 in Australia which resulted in the production of 2.5 milligrams of pure radium bromide, it is reported that 350 milligrams more are in the laboratory in various stages of purification. Recently two American firms have been organized for the preparation of radium salts, etc.; one of these is marketing radium salts and applicators, radium drinking water, radium bath water, radium compresses, and radioactive earth.—*The Journal of Industrial and Engineering Chemistry*.

The Distribution of Luminosity in Nature*

Great Brightness Below the Horizon is Painfully Felt by the Eye

By Herbert E. Ives and M. Luckiesh

In natural daylight illumination one finds some of the most pleasing distributions of light. However, it is still an open question whether under the practice of continuing human activities into the night, a practice comparatively new in terms of the history of the race, the same character of illumination conditions as in the daylight are best. Whatever one's opinion, or the ultimate weight of evidence as to the advisability of imitating daylight at night, is it nevertheless of interest and importance to know with some definiteness what the pleasant daylight conditions actually are. It was thought proper to study surface brightness rather than intensity of illumination because the various surfaces out of doors are of different reflecting power from those of interiors. A close reproduction of the direction, intensity, and diffusion of daylight would not necessarily give a similar result in a room while a distribution of surface brightness could be copied by proper choice of wall coverings and furniture.

APPARATUS AND METHOD EMPLOYED

A photographic method was chosen. In order to use the photographic plate in photometry, its sensibility to lights of different colors must be like that of the eye. Consequently a "ray filter" was made which would make photographic action for different colors proportional to visual brightness. Such a screen was made by the use of various dyes in gelatin films on plate glass. The accuracy with which the ray filter performs its duty with the plate used is shown in Fig. 1.

The visual field of the eye extends from 50° above the horizontal to 70° below. A camera, shown in Fig. 2, was arranged to tilt about a horizontal axis. A sufficient number of photographs were taken to obtain the whole normal vertical visual field. The average brightness was obtained for the various horizontal planes by the use of a cylindrical lens (a bottle containing choral

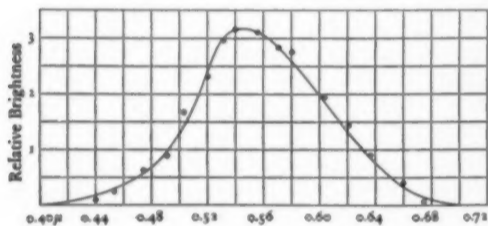


Fig. 1.—Wave lengths.

— Luminosity-curve of white light spectrum.
 Rendering of this curve by plates and ray filter used.

hydrate and glycerin) which left the vertical definition unaffected but had the effect of throwing everything badly out of focus horizontally. The diaphragms shown in Fig. 2 were used in front of the plates. First the

* Paper presented before the Illuminating Engineering Society and published in the *Trans. Illum. Eng. Soc.*



Fig. 2.—Special camera for photographing the vertical distribution of brightness.



Fig. 3.—A park scene.



Fig. 4.—A glaring street at midday.

left-handed one was used without the cylindrical lens. This reproduced the scene on the photographic plate, leaving a blank space in the middle. With the other diaphragm the bottle was used, giving in the middle of the plate densities which indicate the vertical distribution of brightness, as seen in Figs. 3 and 4. These densities were measured and used to plot the polar diagrams 3a and 4a.

RESULTS

Various pleasant and unpleasant scenes were studied. Figs. 3 and 3a show a decidedly pleasant scene in a park. The difference in distribution of brightness in pleasant and unpleasant scenes is striking, as illustrated in Figs. 3 and 4. Figs. 4 and 4a show a decidedly unpleasant scene. There is a large range of high brightness below the horizontal line of vision in the unpleasant case.

One fact brought out by the investigation is that the eye will tolerate a greater brightness above than below the horizontal. A case of an overcast sky shows that the eye will not tolerate too great a flux above the horizontal. In the best landscapes studied the ideal condition seemed to be a preponderance of brightness in the sky with a foreground showing marked varieties of light and shade occasioned by the direct light of the sun falling rather obliquely.

Lumeter measurements of brightness were made, some of which are given here. Blue sky measured 2.2 candle-power per square inch. A cumulus cloud in the same sky measured 10.4 candle-power per square inch. Overcast sky on a rainy day measured 3.3 candle-power per square inch, and on a darker overcast day fell to 1 candle-power per square inch. Cement pavement in

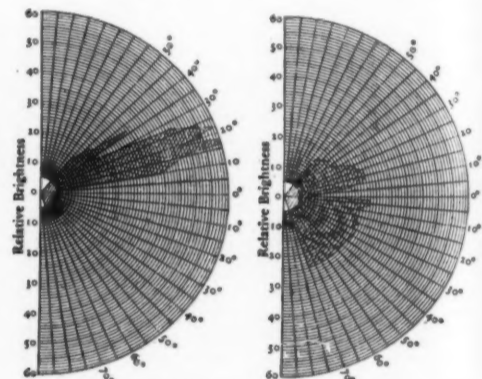


Fig. 3a.—Vertical distribution of brightness for Fig. 3.

Fig. 4a.—Vertical distribution of brightness for Fig. 4.

the sun measured 6 candle-power per square inch. The ratio of the brightest and darkest points of the average vertical distribution of the most varied landscape (Fig. 3) was about 20 to 1. The brightest white cloud measured about one half the intrinsic brightness of a Welsbach mantle.

The Internal Combustion Engine Applied to Railway Locomotion

In a paper read before the British Association for the Advancement of Science by F. W. Lancashire, it was pointed out that the steam locomotive, after having survived for nearly a century with all its essential features practically unchanged, appears to show signs that it is about to yield supremacy to other methods of traction. A brief review of the various tentative directions in which effort is being expended shows that the position of the steam locomotive is being assailed on the one hand by schemes of electrification, and on the other by the development of the internal combustion engine, and more particularly by self-propelled independent units—otherwise known as motor-coaches. The modern development of the motor-coach that formed the subject of the paper.

Various systems by which the internal combustion engine was applied to railway traction were discussed and by process of elimination Mr. Lancashire deduced that for the conditions of British railways, at least, the most promising solution is found in a straightforward piece of engineering, in which all the main elements, the internal combustion motor, the gear-box, the jointed transmission-shaft, and the right-angle drive, also the auxiliary electrical equipment, are taken *mutatis mutandis*

from motor-car practice. It was pointed out that though the component parts of the railway coach thus constituted and the motor-car are analogous, there are certain functional differences, or differences in the object aimed at, which render considerable variations of method and proportion necessary.

The paper described in detail a recent development of the self-propelled railway coach in the form of a vehicle built by the Metropolitan Waggon Company and equipped with its power installation by the Daimler Company. The general lines of the coach—a 60-foot bogie—were described, and the installation was given as being furnished in duplicate, each power unit comprising a six-cylinder sleeve-valve Daimler engine of six-inch bore and six-inch stroke, a triple-tandem six-speed epicyclic gear-box, in which the speeds are grouped as three low-gear ratios, whose function is mainly in starting and giving high acceleration, and three-gear ratios, which are exclusively used for running at speed. The whole of the gears are actuated by clutches of the magnetic type. The right-angle transmission is fitted to a prolongation to one of the bogie axles, and consists of a bevel drive, in which the pinion on the tail shaft gears simultaneously into two crown-wheels on the axle, an alternative dog-clutch being arranged to

bring one or the other into positive connection. By this means the reversal of the car is effected.

The two units are disposed symmetrically on opposite sides of the vehicle, and drive on to opposite ends, so that the job is entirely symmetrical. The vehicle can be controlled from either end, drivers' cabins and duplicate controllers being fitted. The electric equipment consists of dynamos coupled direct to the tail ends of the respective engine crank-shafts and an accumulator battery, and serves both for starting the engines and for lighting purposes and driving an electric air-compressor to operate the air-brake.

The Presence of Rare Metals in Mineral Waters

M. JACQUES BARDET has made a whole series of researches concerning the presence of metals in mineral waters. These experiments, made by means of a spectrograph, have led the author to discover in mineral waters the presence of a large number of metallic elements that were entirely unsuspected; among others that are very frequent, that of germanium and of gallium, bodies the existence of which had up till now only been remarked in very rare minerals.—*The Chemical News.*

Explosive Golf Balls*

A SWIFTLY moving golf ball can strike a severe and painful blow, and it would doubtless be easy to cite cases in which accidents of this kind have ended fatally. There are few, however, who realize that golf balls can do harm in any other way, and yet balls of a certain kind do possess inherent dangers that give rise to serious injuries every little while. To understand the nature of the danger clearly, it is necessary to understand the construction

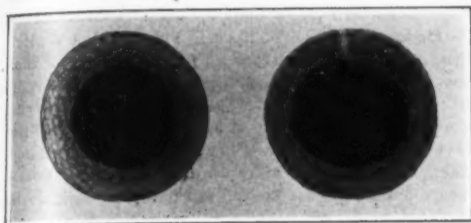


Fig. 1.—An X-ray photograph of two different makes of golf balls.

tion of the modern golf ball, and to know that it is far from being a mere homogeneous lump of matter.

The game of golf is now played all over the world, and the large revenues that are derived by manufacturers and patentees from the sale of the balls have stirred up the inventive genius of the layman and the expert to such an extent that golf balls have been placed on the market in innumerable variety. The first ball we know of, in the history of practical golf, consisted of clippings of paper, cloth, and like materials, pressed into a roughly spherical form, and incased in an outer covering of canvas, with sewn seams.

Various changes in the construction of golf balls followed, but the first real improvement was the introduction of the solid "guttie" ball, made by running melted gutta percha into molds, and allowing it to set under pressure. Shortly after the introduction of solid gutta percha balls distinguishing features were adopted for them, by making the molds with distinctive patterns, consisting usually of square or round indentations, which gave the balls the pipped surfaces that are now so familiar.

Following the "solid gutty" ball came the "hollow solid gutty" ball, which had a spherical cavity in the center. Sometimes a few small steel pellets were placed in the cavity. Sometimes mercury was used. Plugs, weighted at one end, were screwed into the ball with their weighted ends entering the cavity. Air under pressure was introduced from the outside, through a small hole, and the hole was afterward plugged. Acids and chemicals were placed in the cavity to generate gas. All of these methods and constructions were more or less successful, but as the game progressed greater resilience and traveling power was demanded all the time, and finally the rubber-wound ball was invented. This is considered the greatest single improvement that has been made in the golf ball. A core of hard rubber, cork, or wood, solid at first, but subsequently hollow, was wound with rubber tape under tension, and an outer covering of gutta percha was then molded around this winding. Two sizes of windings were

subsequently used, a primary one of rubber thread, and an outer one of rubber tape.

Following close upon the rubber-wound ball came the liquid-cored ball. In making this type, water was injected under pressure into a small rubber bag, which was then tied at the neck and used as a core, being wound with rubber and fitted with an outer cover, as already described. To strengthen the core, two bags were sometimes used, one inside of the other. The liquid-core ball was one of the most successful ever placed on the market, although some players insisted that it was too lively on a "short approach."

Some of the balls that are now in favor among golf players have liquid or pasty centers of a corrosive and exceedingly irritating nature, wound about with strings or ribbons of rubber under tension. Players who know about these balls appear to be almost universally of the opinion that they are all imported, but we are credibly informed that many of them are made in this country. The liquid or pasty center, being under a considerable pressure, flies out, and often with considerable force, through any opening that offers release. Among the many substances that are said to have been found in such balls are hydrochloric acid, sulphuric acid, and pastes or solutions of caustic soda, soap, barium sulphate, zinc chloride, and zinc sulphate. Each of these substances has been introduced, no doubt, with some definite purpose in view. In some cases the purpose probably was to generate carbon dioxide, or some other gas, in the interior of the ball after the liquid core had been inclosed in its rubber wrappings; but in the other cases it is hard to guess what the manufacturer had in mind.

Two serious accidents from corrosive-centered balls recently occurred, in the vicinity of Boston, almost simultaneously. The victims, in both cases, were young boys who had picked up the golf balls, and who were entirely unaware of their dangerous properties.

It is stated that one of the boys had found a ball, and was playing with it in the morning, while he was still in bed. He was picking at the outer covering of the ball when suddenly it burst and the corrosive contents flew into his face. A physician who was summoned advised the boy's removal to the Massachusetts Eye and Ear Infirmary. He was examined upon arriving there, and it was found that, in addition to the infliction of severe burns on his face, the sight of the left eye was entirely destroyed.

On the following day another boy was brought to the Infirmary, suffering from burns on his face. He had found a ball from which the outer covering had been removed and was bouncing it upon the sidewalk when it burst and discharged its corrosive contents over him. In this case, the greater part of the acid went upon the boy's coat, but a small portion splattered upon his face and into his eyes, causing intense pain. The specialists who examined the boy stated that he would have been totally blinded, if a larger quantity had found its way into his eyes. Similar accidents have occurred in considerable number, at different times and in various sections of the country.

The United States Golf Association has issued a notice, in the form of a printed card, warning persons against cutting open golf balls of any kind, and copies of it have been sent to the various golf clubs all over the country. It reads as follows:

"IMPORTANT NOTICE,—WARNING!"

"Owing to the fact that several serious accidents have occurred in the past few years, due to cutting open certain makes of golf balls containing acids and other sight-destroying compounds, the United States Golf Association warns all persons to refrain from this dangerous practice.

EXECUTIVE COMMITTEE,
U. S. G. A."

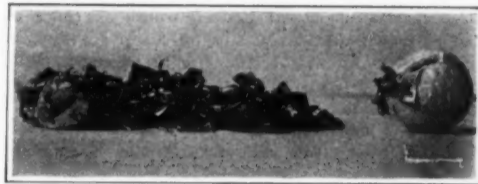


Fig. 2.—One of the golf balls, shown in Fig. 1, cut open, and its contents removed.

In Fig. 1 we give an X-ray picture of two golf balls of different makes that were furnished to us as having fluid or pasty cores. The one shown on the left, in fact, was supposed to be identically like one of the two balls that injured the Boston boys, as described above. In each case the dark central area corresponds to the core of the ball, which was fairly opaque to the X-rays. The outer ring, of lighter shade, corresponds to the rubber that is wound tightly upon the central core, and surrounded by a thin gutta percha covering.

The markings that can be seen upon these outer rings correspond to the patterns that are upon the balls themselves, externally, these showing because the markings are raised, and they therefore vary the transparency of the ball from point to point.

After the X-ray picture was taken, these balls were perforated by drilling into them, suitable precautions being taken to prevent injury. When the drill struck the central portion, the contents of the core (which proved to be pasty instead of liquid) escaped until the interior pressure was relieved in great measure. When the balls were afterward opened up with a hack saw, the rubber windings that had enveloped the cores escaped from the openings made by the saw, before the balls were cut half way across. It was evident that these windings were still in a state of considerable tension, although they had been cut in many places by the saw. Fig. 2 shows the appearance of one of the balls, after the rubber contents had come away from it entirely.

We examined the pasty contents of these balls, in our chemical laboratory. In the case of the ball that was supposed to be like one of the Boston ones, the paste was practically neutral in reaction, and it proved to be a mere mixture of sulphate of zinc and water. An analysis made elsewhere of the contents of the Boston ball indicated zinc chloride instead of zinc sulphate. We shall not attempt to explain the disagreement.

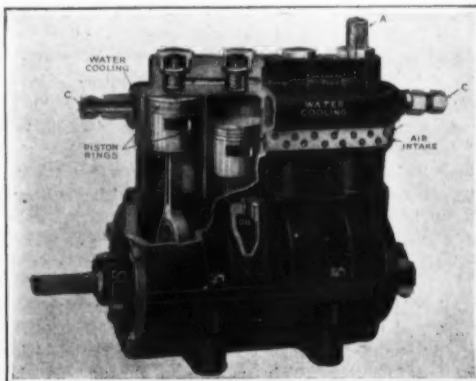
The other of the two balls shown in Fig. 1 was filled with a dark colored paste which we found to be quite alkaline, and which consisted of an insoluble soap, apparently having lime and soda as its bases. A certain amount of magnesia was also present, and the dark color was due to the presence of iron.

A New Four-Cylinder Air Pump

A NEW air pump built especially for use on automobiles and motor trucks, but available in many other lines as well, has just been placed on the market by a well known manufacturer of automobile accessories. This pump is constructed along somewhat radical lines, being built like, and resembling, a four-cylinder automobile motor. It has real motor bearings, metal pistons, double piston rings, hardened connecting rods, a splash oiling system and many other features that cause it to resemble the usual type of internal combustion engine.

There are two models of the pump, one having two cylinders and the other four, each being made in the air-cooled and water-cooled types. The outside dimensions of the four-cylinder model are: Height, 8 inches; width, 4 inches; length, 7½ inches. The cylinders have a bore of 17/16 inches and a stroke of 11/8 inches. The crank-case and cylinders are made of fine gray iron, while the piston heads are die cast to the exact size. The connecting rods are driven by means

of eccentrics working within the lower ends of the rods.



Four-Cylinder Air Pump.

As will be seen in the accompanying illustration of the four-cylinder model, the intake is valveless, air being admitted to the cylinders through apertures in the cylinder walls just above the piston head when the piston is in its lowest position. This air intake is screened so that only pure air is pumped. The model shown is of the water-cooled type. At either end of the water chambers are pipe unions C C for connecting the water circulating system with the pump. Where the pump is used in conjunction with an automobile motor, it is easily connected with the regular water circulating system. At A is seen the air outlet located above cylinder No. 1.

For automobile purposes the pump is essentially a tire inflator, but it may also be used for supplying compressed air to a storage tank where a pneumatic engine starter or gear shifter is installed on the car. The pump produces four compression impulses with each revolution of the crank shaft, which means 2,000 impulses at a speed of 500 revolutions, giving practically a steady flow of air.

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Continuity—II

The Atomistic Trend of Modern Research, and a Plea for Conservatism

Presidential Address Before the British Association

By Sir Oliver Lodge

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 1908, Page 183, September 20, 1913

Now the facts are that no motion with reference to ether alone has ever yet been observed: there are always curious compensating effects which just cancel out the movement-terms and destroy or effectively mask any phenomenon that might otherwise be expected. When matter moves past matter observation can be made; but, even so, no consequent locomotion of ether, outside the actually moving particles, can be detected.

To detect motion through ether we must use an etherial process. We may use radiation, and try to compare the speeds of light along or across the motion; or we might try to measure the speed, first with the motion and then against it. But how are we to make the comparison? If the time of emission from a distant source is given by a distant clock, that clock must be observed through a telescope, that is by a beam of light; which is plainly a compensating process. Or the light from a neighboring source can be sent back to us by a distant mirror; when again there will be compensation. Or the starting of light from a distant terrestrial source may be telegraphed to us, either with a wire or without; but it is the ether that conveys the message in either case, so again there will be compensation. Electricity, Magnetism, and Light, are all effects of the ether.

Use Cohesion, then; have a rod stretching from one place to another, and measure that. But cohesion is transmitted by the ether, too, if, as believed, it is the universal binding medium. Compensation is likely; compensation can, on the electrical theory of matter, be predicted.

Use some action not dependent on Ether, then. Very well, where shall we find it?

To illustrate the difficulty I will quote a sentence from Sir Joseph Larmor's paper before the International Congress of Mathematicians at Cambridge last year.

"If it is correct to say with Maxwell that all radiation is an electrodynamic phenomenon, it is equally correct to say with him that all electrodynamic relations between material bodies are established by the operation, on the molecules of those bodies, of fields of force which are propagated in free space as radiation and in accordance with the laws of radiation, from one body to the other."

The fact is we are living in an epoch of some very comprehensive generalizations. The physical discovery of the twentieth century, so far, is the Electrical Theory of Matter. This is the great new theory of our time; it was referred to, in its philosophical aspect, by Mr. Ralfour in his Presidential Address at Cambridge in 1904. We are too near it to be able to contemplate it properly; it has still to establish itself and to develop in detail, but I anticipate that in some form or other it will prove true.

Here is a briefest possible summary of the first chapter (so to speak) of the Electrical Theory of Matter:

- (1) Atoms of Matter are composed of electrons—of positive and negative electric charges.
- (2) Atoms are bound together into molecules by chemical affinity which is intense electrical attraction at ultra-minute distances.
- (3) Molecules are held together by cohesion, which I for one regard as residual or differential chemical affinity over molecular distances.
- (4) Magnetism is due to the locomotion of electrons. There is no magnetism without an electric current, atomic or otherwise. There is no electric current without a moving electron.
- (5) Radiation is generated by every accelerated electron, in amount proportional to the square of its acceleration; and there is no other kind of radiation, except indeed a corpuscular kind; but this depends on the velocity of electrons and therefore again can only be generated by their acceleration.

The theory is bound to have curious consequences; and already it has contributed to some of the uprooting and uncertainty that I speak of. For, if it be true, every material interaction will be electrical, i. e., etherial; and hence arises our difficulty. Every kind of force is transmitted by the ether, and hence, so long as all our apparatus is traveling together at one and the same pace, we have no chance of detecting the motion. That is the strength of the Principle of Relativity. The

changes are not zero, but they cancel each other out of observation.

Surely, however, the minute and curious compensations cannot be accidental, they must be necessary. Yes, they are necessary; and I want to say why. Suppose the case were one of measuring thermal expansion; and suppose everything had the same temperature and the same expansibility; our standards would contract or expand with everything else, and we could observe nothing; but expansion would occur nevertheless. That is obvious, but the following assertion is not so obvious. If everything in the Universe had the same temperature, no matter what that temperature was, nothing would be visible at all; the external world, so far as vision went, would not appear to exist. Visibility depends on radiation, on differential radiation. We must have differences to appeal to our senses, they are not constructed for uniformity.

It is the extreme omnipresence and uniformity and universal agency of the ether of space that makes it so difficult to observe. To observe anything you must have differences. If all actions at a distance are conducted at the same rate through the ether, the travel of none of them can be observed. Find something not conveyed by the ether and there is a chance. But then every physical action is transmitted by the ether, and in every case by means of its transverse or radiation-like activity.

Except perhaps Gravitation. That may give us a clue some day, but at present we have not been able to detect its speed of transmission at all. No plan has been devised for measuring it. Nothing short of the creation or destruction of matter seems likely to serve: creation or destruction of the gravitational unit, whether it be an atom or an electron or whatever it is. Most likely the unit of weight is an electron, just as the unit of mass is.

The so-called non-Newtonian Mechanics, with mass and shape a function of velocity, is an immediate consequence of the electrical theory of matter. The dependence of inertia and shape on speed is a genuine discovery and, I believe, a physical fact. The Principle of Relativity would reduce it to a conventional fiction. It would seek to replace this real change in matter by imaginary changes in time. But surely we must admit that Space and Time are essentially unchangeable: they are not at the disposal even of mathematicians; though it is true that Pope Gregory, or a Daylight-saving Bill, can play with our units, can turn the 3rd of October in any one year into the 14th, or can make the sun South sometimes at eleven o'clock, sometimes at twelve.

But the changes of dimension and mass due to velocity are not conventions but realities; so I urge, on the basis of the electrical theory of matter. The Fitzgerald-Lorentz hypothesis I have an affection for. I was present at its birth. Indeed I assisted at its birth; for it was in my study at 21 Waverley Road, Liverpool, with Fitzgerald in an arm chair, and while I was enlarging on the difficulty of reconciling the then new Michelson experiment with the theory of astronomical aberration and with other known facts, that he made his brilliant surmise:—"Perhaps the stone slab was affected by the motion." I rejoined that it was a 45° shear that was needed. To which he replied, "Well, that's all right,—a simple distortion." And very soon he said, "And I believe it occurs, and that the Michelson experiment demonstrates it." A shortening long-ways, or a lengthening cross-ways would do what was wanted.

And is such a hypothesis gratuitous? Not at all: in the light of the electrical theory of matter such an effect ought to occur. The amount required by the experiment, and given by the theory, is equivalent to a shrinkage of the earth's diameter by rather less than three inches, in the line of its orbital motion through the ether of space. An oblate spheroid with the proper excentricity has all the simple geometrical properties of a stationary sphere; the excentricity depends in a definite way on speed, and becomes considerable as the velocity of light is approached.

All this Professors Lorentz and Larmor very soon after, and quite independently, perceived; though this is only one of the minor achievements in the electrical theory of matter which we owe to our distinguished visitor, Professor H. A. Lorentz.

The electrical theory of matter is a positive achievement, and has positive results. By its aid we make experiments which throw light upon the relation between matter and the Ether of Space. The Principle of Relativity, which seeks to replace it, is a principle of negation, a negative proposition, a statement that observation of certain facts can never be made, a denial of any relation between matter and ether, a virtual denial that the ether exists. Whereas, if we admit the real changes that go on by reason of rapid motion, a whole field is open for discovery; it is even possible to investigate the changes in shape of an electron—appallingly minute though it is—as it approaches the speed of light; and properties belonging to the Ether of Space, evasive though it be, cannot lag far behind.

Speaking as a physicist I must claim the Ether as peculiarly our own domain. The study of molecules we share with the chemist, and matter in its various forms is investigated by all men of science, but a study of the ether of space belongs to physics only. I am not alone in feeling the fascination of this portentous entity. Its curiously elusive and intangible character, combined with its universal and unifying permanence, its apparently infinite extent, its definite and perfect properties, make the ether the most interesting as it is by far the largest and most fundamental ingredient in the material cosmos.

As Sir J. J. Thomson said at Winnipeg:

"The ether is not a fantastic creation of the speculative philosopher; it is as essential to us as the air we breathe. . . . The study of this all-pervading substance is perhaps the most fascinating and important duty of the physicist."

Matter it is not, but material it is; it belongs to the material universe and is to be investigated by ordinary methods. But to say this is by no means to deny that it may have mental and spiritual functions to subserve in some other order of existence, as Matter has in this.

The ether of space is at least the great engine of continuity. It may be much more, for without it there could hardly be a material universe at all. Certainly, however, it is essential to continuity; it is the one all-permeating substance that binds the whole of the particles of matter together. It is the uniting and binding medium without which, if matter could exist at all, it could exist only as chaotic and isolated fragments; and it is the universal medium of communication between worlds and particles. And yet it is possible for people to deny its existence, because it is unrelated to any of our senses, except sight,—and to that only in an indirect and not easily recognized fashion.

To illustrate the thorough way in which we may be unable to detect what is around us unless it has some link or bond which enables it to make appeal, let me make another quotation from Sir J. J. Thomson's Address at Winnipeg in 1900. He is leading up to the fact that even single atoms, provided they are fully electrified with the proper atomic charge, can be detected by certain delicate instruments—their field of force bringing them within our ken—whereas a whole crowd of unelectrified ones would escape observation.

"The smallest quantity of unelectrified matter ever detected is probably that of neon, one of the inert gases of the atmosphere. Professor Strutt has shown that the amount of neon in 1/20 of a cubic centimetre of the air at ordinary pressures can be detected by the spectro-scope; Sir William Ramsay estimates that the neon in the air only amounts to one part of neon in 100,000 parts of air, so that the neon in 1/20 of a cubic centimetre of air would only occupy at atmospheric pressure a volume of half a millionth of a cubic centimetre. When stated in this form the quantity seems exceedingly small, but in this small volume there are about ten million million molecules. Now the population of the earth is estimated at about fifteen hundred millions, so that the smallest number of molecules of neon we can identify is about 7,000 times the population of the earth. In other words, if we had no better test for the existence of a man than we have for that of an unelectrified molecule we should come to the conclusion that the earth is uninhabited."

The parable is a striking one, for on these lines it might legitimately be contended that we have no right to say positively that even space is uninhabited. All

we can safely say is that we have no means of detecting the existence of non-planetary immaterial dwellers, and that unless they have some link or bond with the material they must always be physically beyond our ken. We may, therefore, for practical purposes, legitimately treat them as non-existent until such link is discovered, but we should not dogmatize about them. True agnosticism is legitimate, but not the dogmatic and positive and gnostic variety.

For I hold that Science is incompetent to make comprehensive denials, even about the Ether, and that it goes wrong when it makes the attempt. Science should not deal in negations; it is strong in affirmations, but nothing based on abstraction ought to presume to deny outside its own region. It often happens that things abstracted from and ignored by one branch of science may be taken into consideration by another.

Thus, Chemists ignore the Ether; Mathematicians may ignore experimental difficulties; Physicists ignore and exclude live things; Biologists exclude Mind and Design; Psychologists may ignore human origin and human destiny; folk-lore students and comparative Mythologists need not trouble about what modicum of truth there may be in the legends which they are collecting and systematizing; and microscopists may ignore the stars. Yet none of these ignored things should be denied.

Denial is no more infallible than assertion. There are cheap and easy kinds of skepticism, just as there are cheap and easy kinds of dogmatism; in fact, skepticism can become viciously dogmatic, and science has to be as much on its guard against personal predilection in the negative as in the positive direction. An attitude of universal denial may be very superficial.

"To doubt everything or to believe everything are two equally convenient solutions; both dispense with the necessity of reflection."

All intellectual processes are based on abstraction. For instance, History must ignore a great multitude of facts in order to treat any intelligently: it selects. So does Art; and that is why a drawing is clearer than reality. Science makes a diagram of reality, displaying the works, like a skeleton clock. Anatomists dissect out the nervous system, the blood vessels, and the muscles, and depict them separately,—there must be discrimination for intellectual grasp—but in life they are all merged and co-operating together; they do not really work separately, though they may be studied separately. A scalpel discriminates; a dagger or a bullet crashes through everything. That is life—or rather death. The laws of nature are a diagrammatic framework, analyzed or abstracted out of the full comprehensiveness of reality.

Hence it is that Science has no authority in denials. To deny effectively needs much more comprehensive knowledge than to assert. And abstraction is essentially not comprehensive; one cannot have it both ways. Science employs the methods of abstraction and thereby makes its discoveries.

The reason why some physiologists insist so strenuously on the validity and self-sufficiency of the laws of physics and chemistry, and resist the temptation to appeal to unknown causes—even though the guiding influence and spontaneity of living things are occasionally conspicuous as well as inexplicable—is that they are keen to do their proper work; and their proper work is to pursue the laws of ordinary physical Energy into the intricacies of "colloidal electrolytic structures of great chemical complexity" and to study its behavior there.

What we have clearly to grasp, on their testimony, is that for all the terrestrial manifestations of life the ordinary physical and chemical processes have to serve. There are not new laws for living matter, and old laws for non-living, the laws are the same; or if ever they differ, the burden of proof rests on him who sustains the difference. The conservation of energy, the laws of chemical combination, the laws of electric currents, of radiation, etc., etc.—all the laws of Chemistry and Physics—may be applied without hesitation in the Organic domain. Whether they are sufficient is open to question, but as far as they go they are necessary; and it is the business of the physiologist to seek out and demonstrate the action of those laws in every vital action.

I observe that by some critics I have been called a vitalist, and in a sense I am; but I am not a vitalist. If vitalism means an appeal to an undefined "vital force" (an objectionable term I have never thought of using) as against the laws of Chemistry and Physics. Those laws must be supplemented, but need by no means be superseded. The business of science is to trace out their mode of action everywhere, as far and as fully as possible; and it is a true instinct which resents the mediæval practice of freely introducing spiritual and unknown causes into working science. In science an appeal to occult qualities must be illegitimate, and be a barrier to experiment and research generally; as, when

anything is called an Act of God—and when no more is said. The occurrence is left unexplained. As an ultimate statement such a phrase may be not only true but universal in its application. But there are always proximate explanations which may be looked for and discovered with patience. So, lightning, earthquakes, and other portents are reduced to natural causes. No ultimate explanation is ever attained by science: proximate explanations only. They are what it exists for; and it is the business of scientific men to seek them.

To attribute the rise of sap to vital force would be absurd, it would be giving up the problem and stating nothing at all. The way in which osmosis acts to produce the remarkable and surprising effect is discoverable and has been discovered.

So it is always in science, and its progress began when unknown causes were eliminated and treated as non-existent. Those causes, so far as they exist, must establish their footing by direct investigation and research; carried on in the first instance apart from the long recognized branches of science, until the time when they too have become sufficiently definite to be entitled to be called scientific. Outlandish Territories may in time be incorporated as States, but they must make their claim good and become civilized first.

It is well for people to understand this definite limitation of scope quite clearly, else they wrest the splendid work of biologists to their own confusion—helped it is true by a few of the more robust or less responsible theorists, among those who should be better informed and more carefully critical in their philosophizing utterances.

But, as is well known, there are more than a few biologists who, when taking a broad survey of their subject, clearly perceive and teach that before all the actions of live things are fully explained, some hitherto excluded causes must be postulated. Ever since the time of J. R. Mayer it has been becoming more and more certain that, as regards performance of work, a living thing obeys the laws of physics, like everything else; but undoubtedly it initiates processes and produces results that without it could not have occurred—from a bird's nest to a honeycomb, from a deal box to a warship. The behavior of a ship firing shot and shell is explicable in terms of energy, but the discrimination which it exercises between friend and foe is not so explicable. There is plenty of physics and chemistry and mechanics about every vital action, but for a complete understanding of it something beyond physics and chemistry is needed.

And life introduces an incalculable element. The vagaries of a fire or a cyclone could all be predicted by Laplace's Calculator, given the initial positions, velocities, and the law of acceleration of the molecules; but no mathematician could calculate the orbit of a common house-fly. A physicist into whose galvanometer a spider had crept would be liable to get phenomena of a kind quite inexplicable, until he discovered the supernatural, i. e., literally superphysical, cause. I will risk the assertion that Life introduces something incalculable and purposeful amid the laws of physics; it thus distinctly supplements those laws, though it leaves them otherwise precisely as they were and obeys them all.

We see only its effect, we do not see Life itself. Conversion of Inorganic into Organic is effected always by living organisms. The conversion under those conditions certainly occurs, and the process may be studied. Life appears necessary to the conversion; which clearly takes place under the guidance of life, though in itself it is a physical and chemical process. Many laboratory conversions take place under the guidance of life, and, but for the experimenter, would not have occurred.

Again, putrefaction, and fermentation, and purification of rivers, and disease, are not purely and solely chemical processes. Chemical processes they are, but they are initiated and conducted by living organisms. Just when medicine is becoming biological, and when the hope of making the tropical belt of the earth healthily habitable by energetic races is attracting the attention of people of power, philosophizing biologists should not attempt to give their science away to Chemistry and Physics. Biology is an independent science, and it is served, not dominated, by Chemistry and Physics.

Scientific men are hostile to superstition, and rightly so, for a great many popular superstitions are both annoying and contemptible; yet occasionally the term may be wrongly applied to practices of which the theory is unknown. To a superficial observer some of the practices of biologists themselves must appear grossly superstitious. To combat malaria Sir Ronald Ross does not indeed erect an altar; no, he oils a pond—making libation to its presiding genii. What can be more ludicrous than the curious and evidently savage ritual, insisted on by United States Officers, at that hygienically splendid achievement, the Panama Canal—the ritual of punching a hole in every discarded tin, with the object

of keeping off disease! What more absurd, again—in superficial appearance—than the practice of burning or poisoning a soil to make it extra fertile!

What appears to be quite certain is that there can be no terrestrial manifestation of life without matter. Hence naturally biologists say, or they approve such sayings as, "I discern in matter the promise and potency of all forms of life." Of all terrestrial manifestations of life, certainly. How else could it manifest itself save through matter? "I detect nothing in the organism but the laws of Chemistry and Physics," it is said. Very well: naturally enough. That is what they are after; they are studying the physical and chemical aspects or manifestations of life. But life itself—life and mind and consciousness—they are not studying, and they exclude them from their purview. Matter is what appeals to our senses here and now; Materialism is appropriate to the material world; not as a philosophy but as a working creed, as a proximate and immediate formula for guiding research. Everything beyond that belongs to another region, and must be reached by other methods. To explain the Physical in terms of Physics and Chemistry is simply impossible; hence there is a tendency to deny its existence, save as an epiphenomenon. But all such philosophizing is unjustified, and is really bad Metaphysics.

But although Life and Mind may be excluded from Physiology, they are not excluded from Science. Of course not. It is not reasonable to say that things necessarily elude investigation merely because we do not know against them. Yet the mistake is sometimes made. The ether makes no appeal to sense, therefore some are beginning to say that it does not exist. Mind is occasionally put into the same predicament. Life is not detected in the laboratory, save in its physical and chemical manifestations; but we may have to admit that it guides processes nevertheless. It may be called a catalytic agent.

To understand the action of life itself, the simplest plan is not to think of a microscopic organism, or any unfamiliar animal, but to make use of our own experience as living beings. Any positive instance serves to stem a comprehensive denial; and if the reality of mind and guidance and plan is denied because they make no appeal to sense, then think how the world would appear to an observer to whom the existence of men was unknown and undiscoverable, while yet all the laws and activities of nature went on as they do now.

Suppose, then, that *man* made no appeal to the senses of an observer of this planet. Suppose an outside observer could see all the events occurring in the world, save only that he could not see animals or men. He would describe what he saw much as we have to describe the activities initiated by life.

If he looked at the Firth of Forth, for instance, he would see piers arising in the water, beginning to sprout, reaching across in strange manner till they actually join or are joined by pieces attracted up from below to complete the circuit (a solid circuit round the current). He would see a sort of bridge or filament thus constructed, from one shore to the other, and across this bridge insect-like things crawling and returning for no very obvious reason.

Or let him look at the Nile, and recognize the meritorious character of that river in promoting the growth of vegetation in the desert. Then let him see a kind of untoward crystallization growing across and beginning to dam the beneficent stream. Blocks fly to their places by some kind of polar forces; "we cannot doubt" that it is by helio- or other tropism. There is no need to go outside the laws of mechanics and physics, there is no difficulty about supply of energy—none whatever—materials in tin cans are consumed which amply account for all the energy; and all the laws of physics are obeyed. The absence of any design, too, is manifest; for the effect of the structure is to flood an area up-stream which might have been useful, and to submerge a structure of some beauty; while down-stream its effect is likely to be worse, for it would block the course of the river and waste it on the desert, were it not that fortunately some leaks develop and a sufficient supply still goes down—goes down, in fact, more equably than before; so that the ultimate result is beneficial to vegetation, and simulates intention.

If told concerning either of these structures that an engineer, a designer in London, called Benjamin Baker, had anything to do with it, the idea would be preposterous. One conclusive argument is final against such a superstitious hypothesis—he is not there, and a thing plainly cannot act where it is not. But although we, with our greater advantages, perceive that the right solution for such an observer would be the recognition of some unknown agency or agent, it must be admitted that an explanation in terms of a vague entity called vital force would be useless, and might be so worded as to be misleading; whereas, a statement in terms of mechanics and physics could be clear and definite and

true as far as it went, though it must necessarily be incomplete.

And note that what we observe, in such understood cases, is an *Interaction of Mind and Matter*; not Parallelism, nor Epiphenomenalism nor anything strained or difficult, but a straightforward utilization of the properties of matter and energy for purposes conceived in the mind, and executed by muscles guided by acts of will.

But, it will be said, this is unfair, for we know that there is design in the Forth Bridge or the Nile Dam; we have seen the plans and understood the agencies at work; we know that it was conceived and guided by life and mind; it is unfair to quote this as though it could simulate an automatic process.

Not at all, say the extreme school of biologists, whom I am criticizing, or ought to say if they were consistent, there is nothing but Chemistry and Physics at work anywhere; and the mental activity apparently demonstrated by those structures is only an illusion, an epiphenomenon; the laws of chemistry and physics are supreme, and they are sufficient to account for everything.

Well, they account for things up to a point; they account in part for the color of a sunset, for the majesty of a mountain peak, for the glory of animate existence. But do they account for everything completely? Do they account for our own feeling of joy and exaltation, for our sense of beauty, for the manifest beauty existing throughout nature? Do not these things suggest something higher and nobler and more joyous, something for the sake of which all the struggle for existence goes on?

Surely there must be a deeper meaning involved in natural objects. Orthodox explanations are only partial, though true as far as they go. When we examine each part-colored pinna in a peacock's tail, or half in a zebra's hide, and realize that the varying shades on each are so placed as to contribute to the general design and pattern, it becomes exceedingly difficult to explain how this organized co-operation of parts, this harmonious distribution of pigment cells, has come about on merely mechanical principles. It would be as easy to explain the sprouting of the cantilevers of the Forth Bridge from its piers, or the flocking of the stones of the Nile Dam by chemotaxis. Flowers attract insects for fertilization; and fruit tempts animals to eat it in order to carry seeds. But these explanations cannot be final. We have still to explain the insects. So much beauty cannot be necessary merely to attract their attention. We have further to explain this competitive striving towards life. Why do things struggle to exist? Surely the effort must have some significance, the development some aim. We thus reach the problem of Existence itself, and the meaning of Evolution.

The mechanism whereby existence entrenches itself is manifest, or at least has been to a large extent discovered. Natural Selection is a vera causa, so far as it goes; but if so much beauty is necessary for insects, what about the beauty of a landscape or of clouds? What utilitarian object do those subserve? Beauty in general is not taken into account by science. Very well, that may be all right, but it exists, nevertheless. It is not my function to discuss it. No; but it is my function to remind you and myself that our studies do not exhaust the Universe, and that if we dogmatize in a negative direction, and say that we can reduce everything to physics and chemistry, we gibbet ourselves as ludicrously narrow pedants, and are falling far short of the richness and fullness of our human birthright. How far preferable is the reverent attitude of the Eastern Poet:

"The world with eyes bent upon thy feet stands in awe with all its silent stars."

Superficially and physically we are very limited. Our sense organs are adapted to the observation of matter; and nothing else directly appeals to us. Our nerve-muscle system is adapted to the production of motion in matter, in desired ways; and nothing else in the material world can we accomplish. Our brain and nerve systems connect us with the rest of the physical world. Our senses give us information about the movements of matter. Our muscles enable us to produce changes in those distributions. That is our equipment for human life; and human history is a record of what we have done with these parsimonious privileges.

But if we have learnt from science that Evolution is real, we have learnt a great deal. I must not venture to philosophize, but certainly from the point of view of science Evolution is a great reality. Surely evolution is not an illusion; surely the universe progresses in time. Time and Space and Matter are abstractions, but are none the less real; they are data given by experience; and Time is the keystone of evolution. "Thy centuries follow each other, perfecting a small wild flower."

We abstract from living moving Reality a certain static aspect, and we call it Matter; we abstract the

element of progressiveness, and we call it Time. When these two abstractions combine, co-operate, interact, we get reality again. It is like Poynting's theorem.

The only way to refute or confuse the theory of Evolution is to introduce the subjectivity of time. That theory involves the reality of time, and it is in this sense that Prof. Bergson uses the great phrase, "Creative Evolution."

I see the whole of material existence as a steady passage from past to future, only the single instant which we call the present being actual. The past is not non-existent, however, it is stored in our memories, there is a record of it in matter, and the present is based upon it; the future is the outcome of the present, and is the product of evolution.

Existence is like the output from a loom. The pattern, the design for weaving, is in some sort "there" already; but whereas our looms are mere machines, once the guiding cards have been fed into them, the Loom of Time is complicated by a multitude of free agents who can modify the web, making the product more beautiful or more ugly according as they are in harmony or disharmony with the general scheme. I venture to maintain that manifest imperfections are thus accounted for, and that freedom could be given on no other terms, nor at any less cost.

The ability thus to work for weal or woe is no illusion, it is a reality, a responsible power which conscious agents possess; wherefore the resulting fabric is not something preordained and inexorable, though by wide knowledge of character it may be inferred. Nothing is inexorable except the uniform progress of time; the cloth must be woven, but the pattern is not wholly fixed and mechanically calculable.

Where inorganic matter alone is concerned, there everything is determined. Wherever full consciousness has entered, new powers arise, and the faculties and desires of the conscious parts of the scheme have an effect upon the whole. It is not guided from outside but from within; and the guiding power is immanent at every instant. Of this guiding power we are a small but not wholly insignificant portion.

That evolutionary progress is real is a doctrine of profound significance, and our efforts at social betterment are justified because we are a part of the scheme, a part that has become conscious, a part that realizes, dimly, at any rate, what it is doing and what it is aiming at. Planning and aiming are therefore not absent from the whole, for we are a part of the whole, and are conscious of them in ourselves.

Either we are immortal beings or we are not. We may not know our destiny, but we must have a destiny of some sort. Those who make denials are just as likely to be wrong as those who make assertions; in fact, denials are assertions thrown into negative form. Scientific men are looked up to as authorities, and should be careful not to mislead. Science may not be able to reveal human destiny, but it certainly should not obscure it. Things are as they are, whether we find them out or not; and if we make rash and false statements, posterity will detect us—if posterity ever troubles its head about us. I am one of those who think that the methods of Science are not so limited in their scope as has been thought: that they can be applied much more widely, and that the Psychic region can be studied and brought under law, too. Allow us anyhow to make the attempt. Give us a fair field. Let those who prefer the materialistic hypothesis by all means develop their thesis as far as they can; but let us try what we can do in the Psychical region, and see which wins. Our methods are really the same as theirs—the subject-matter differs. Neither should abuse the other for making the attempt.

Although I am speaking ex cathedra, as one of the representatives of orthodox science, I will not shrink from a personal note summarizing the result on my own mind of thirty years' experience of psychical research, begun without predilection—indeed with the usual hostile prejudice. This is not the place to enter into details or to discuss facts scorned by orthodox science, but I cannot help remembering that an utterance from this Chair is no ephemeral production, for it remains to be criticised by generations yet unborn, whose knowledge must inevitably be fuller and wider than our own. Your President, therefore, should not be completely bound by the shackles of present-day orthodoxy, nor limited to beliefs fashionable at the time. In justice to myself and my co-workers I must risk annoying my present hearers, not only by leaving on record our conviction that occurrences now regarded as occult can be examined and reduced to order by the methods of science carefully and persistently applied, but by going further and saying, with the utmost brevity, that already the facts so examined have convinced me that memory and affection are not limited to that association with matter by which alone they can manifest themselves here and now, and that personality persists beyond

bodily death. The evidence to my mind goes to prove that discarnate intelligence, under certain conditions, may interact with us on the material side, thus indirectly coming within our scientific ken; and that gradually we may hope to attain some understanding of the nature of a larger, perhaps etherial, existence, and of the conditions regulating intercourse across the chasm.

For the methods of science are not the only way, though they are our way, of arriving at truth. "*Unus itineris non potest perveniri ad tam grande secretum.*"

We cannot seriously suppose that truth began to arrive on this planet a few centuries ago. The pre-scientific insight of genius—of Poets and Prophets and Saints—was of supreme value, and the access of those inspired seers to the heart of the universe was profound. But the camp followers, the scribes and pharisees, by whatever name they may be called, had no such insight, only a vicious or a foolish obstinacy; and the prophets of a new era were stoned.

Now at last we of the new era have been victorious; we inherit the fruits of the age-long conflict, and the stones are in our hands. Let us not fall into the old mistake of thinking that ours is the only way of exploring the multifarious depths of the universe, and that all others are worthless and mistaken. The universe is a larger thing than we have any conception of, and no one method of search will exhaust its treasures.

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